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CHINA: Energy

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China: Energy

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CONTENTS

September Primary Energy Production Figures Reported

40100023 Beijing CEI Database in English 30 Nov 88

[Text] Beijing (CEI)—Following is a chart of China's total output of primary energy production in September 1988, released by CSICSC [China Statistical Information and Consultancy Service Center]:

Item	Unit	1-10/88	10/88	Percentage over 1-10/1987
Total output (10,000 tons of standard coal)		76324.0	7911.0	104.34
A. Raw coal	10,000 tons	76808.0	7934.0	104.72
including: output under unified central planning	10,000 tons	37003.0	3760.0	102.97
B. Crude oil	10,000 tons	11307.7	1184.9	101.83
C. Natural gas	100 million cubic meters	118.7	11.6	100.94
D. Hydropower	100 million kWh	924.6	98.5	111.92

Several Strategies for Promoting Growth of Petrochemical Industry

40130009 Beijing BEIJING KEJI BAO in Chinese 17 Aug 88 p 3

[Article by Zhuo Songnian [0587 2646 1628]: "Some Views on Accelerating the Development of China's Petrochemical Industry"]

[Excerpts] [passage omitted]

II. Views on Accelerating the Development of China's Petrochemical Industry

1. We must have advantages in raw materials, technology, and marketing

The chairman of the board of the British Petroleum Corporation said that during the 1990's, besides raw materials advantages, the world's successful petrochemical companies also must have technical and marketing advantages. How do the world's few main petrochemical industry countries use their advantages?

The United States has petroleum and natural gas resources. When there were abnormal crude oil price increases on international markets, it adopted policies to control the domestic price of petroleum to protect its domestic petrochemical industry, basically maintaining it at a level below the existing price and gradually readjusting it. The United States also took advantage of the relatively cheap production costs of its petrochemical products to export them in large amounts when rising oil prices hurt the petrochemical industries of Japan and Western Europe. The United States exported more than $14 billion in petrochemical products in 1980, double the 1977 amount.

Japan has no petroleum resources, but it does have advantages in its light industry, textile, fine chemical, and other processing industries, and its domestic petrochemical industry has served as a reserve strength. Despite using expensive imported raw materials, they have earned substantial profits by expanding exports of finished products.

The overall level of the Soviet Union's petrochemical industry is backward compared to the United States, Japan, and Western Europe, but it has the world's largest chemical fertilizer and synthetic rubber industries. The Soviet Union has made full use of its petroleum and natural gas resources. During the 1970's, they imported over 40 large synthetic ammonia facilities and made chemical fertilizer a main export product of the Soviet Union's petrochemical industry. The Soviet Union also has marketing advantages in petroleum and oil products. To increase petroleum and oil product exports to the West, the Soviet Union has continually imported crude oil from the Middle East and North Africa and then sold most of it to Western nations. Most of the import fees went for food and military assistance, but it obtained hard currency by selling it to the West.

It is easy to see that a nation which adopts flexible policies and makes full use of its advantages can place its petrochemical industry in a winning position.

2. China's advantages in the petrochemical industry lie in the chemical fiber industry

Textile products traditionally have been one of China's main export commodities. They were second only to crude oil among our export commodities for quite some time. Since 1986, however, China's main source of foreign exchange has shifted from crude oil and oil product exports to the export of textile products.

China already has a fairly strong textile processing capacity, with five large chemical fiber base areas that make us one of the world's main chemical fiber producing countries. There is considerable potential for exporting chemical fibers. China's chemical fiber and mixed textile product exports account for only about 30 percent of our exports of textile products. This figure is about 70 percent in Japan and about 45 percent in South Korea. Italy, and other countries. Projections are that world textile exports will grow at an average yearly rate of 4 percent for more than a decade to come. The yearly rate of growth in chemical fibers and mixed textile exports will not be less than 4 percent.

Besides the need to increase output in future development of the chemical fiber industry, we also should develop various types of new mixed textiles, pure textiles, and interwoven and long fiber textile products. We should develop new textile products used in industry, as well as bedding products, curtains, utility cloth, wall hangings, and other chemical fiber products. We should develop high speed, short flow process, and large capacity chemical fiber textiles, and production facilities for "differentiated chemical fibers." In trade, we should adapt to market demand for products in small amounts, of many varieties and styles, top quality, and quick delivery.

3. On construction sequences in the petrochemical industry

The petrochemical industry can be divided into the three production stages of upstream, midstream, and downstream. Each country can adopt different development patterns based on capital abilities, technical conditions, market development, and other differences. A direct development system would start by manufacturing raw materials and move on to intermediate chemicals, finished products, and post-processing. A reverse development system would first involve post-processing by starting downstream and then producing raw materials after accumulating capital and opening markets.

We should be concerned with whether or not construction of the fine chemical and plastics processing industries conforms to the principle of "less income, more output, rapid output." Chir can adopt a reverse development system and begin by importing production technologies and facilities or even raw materials for major fine chemical industry products and plastic processing and begin from the rear or from a horizontal direction with limited investments, great flexibility, fast results, and high benefits. This would promote accelerated growth of new petrochemical industries and development of the raw materials industry, which in turn would accelerate development of the entire petrochemical industry.

4. Be concerned with developing bioengineering and the natural gas chemical industry

All nations have chosen breakthrough points to develop bioengineering. The United States has chosen to make the pharmaceutical industry its breakthrough point. Japan has chosen the food products industry to make breakthroughs based on its enormous brewing industry. The Soviet Union has taken the relative backwardness of its animal husbandry into consideration and focused on unicellular proteins, feed additives, and other areas.

China's development of bioengineering should integrate with our national conditions and select breakthrough points. The development goal over the next 10-plus years is first to develop several new biotechnology products where technologies in China are mature, which have obvious economic benefits or social benefits, and which have definite foundations and conditions in China. Examples would include monoclonal antibodies, genetically engineered vaccines, amino acid products closely related to the petrochemical industry, new types of food enzyme-produced additives, unicellular proteins, and so on.

China has extremely abundant natural gas resources in excess of about 20 trillion cubic meters. The state has already given natural gas development a status equivalent in importance to petroleum. Exploitation of natural gas may change the raw materials structure of China's petrochemical industry, which in turn would accelerate growth in the petrochemical industry. We can build several synthetic ammonia plants and natural gas chemical industry plants near natural gas fields, and they can be used to make fuels (gasoline, methanol-gasoline mixtures, etc.), generate power, and so on.

Development of the natural gas chemical industry should be included in plans and the relevant scientific research departments should pay more attention to developing the natural gas chemical industry.

5. Exploit potential and increase efficiency, achieve comprehensive integration of oil, chemicals, and fibers

Exploiting potential and transformation produce very high economic benefits. Over the 3-year period from 1986 to 1988, exploitation of potential and transformation in enterprises under the China Petrochemical Corporation increased economic benefits by more than 5 billion yuan. Comprehensive integration of petroleum, chemicals, and fibers can assure supplies of raw materials to production departments. This would aid in raw materials diversification and allow maintaining a certain degree of product price stability.

During structural reforms in its petrochemical industry, Japan focused on dealing with low efficiency equipment in enterprises to restore its international competitiveness.

Standards should be formulated in petrochemical industry enterprises like getting rid of equipment which consumes energy in excess of a set amount or has an efficiency rate lower than a set amount, and backward technologies, and replacing them with new equipment, new techniques, and new technologies.

6. Increase allocations for scientific research, develop technology markets

One-third of the employees in some advanced enterprises in the developed nations are engaged in R&D work. R&D expenditures usually account for 5 to 10 percent of operating expenditures. Some companies like IBM and the Dupont Chemical Corporation spend over $1 billion or even $2 billion-plus on scientific research each year, much more than the Chinese Academy of Sciences spends on scientific research for an entire year. The fact that China spends little on scientific research has impeded technical progress. The result is a great deal of redundant importing, a considerable loss of foreign exchange, a loss of proportion in investments in fixed assets, and a relative decline in returns to investments.

We should encourage the adoption of new techniques, new technologies, and new equipment which have been successfully developed within China, and we should provide preferential policies. We should substantially increase scientific research expenditures in the petrochemical industry.

We should promote the commercialization of technical achievements and speed up the shift of scientific research achievements to industry. This would benefit integrating the economic interests of research organs and production units, and it would aid in promoting competition. This would speed up the transformation of the S&T needs of production into research topics and research achievements into production.

Some 10 to 40 percent of the capital goods exports of the industrialized nations of the West involve non-material trade in the form of consulting services and engineering and technical services. The foreign exchange earned through this type of trade accounts for a sizable proportion of their total foreign exchange income, as much as 20 percent in some countries.

The world now is in the information age. There must be vigorous information and a high tide of technology if China's advantages are to compete better in domestic and international markets.

Strategy for Nuclear Power Development in China

40130010 Beijing HE KEXUE YU GONGCHENG [CHINESE JOURNAL OF NUCLEAR SCIENCE AND ENGINEERING] in Chinese Vol 8 No 1, Mar 88 pp 59-71

[Article by Bao Yunqiao [7637 0061 2884], Zhang Wenqing [1728 2429 7230], Chen Shuyun [7115 2579 0061], and Shi Liang [0670 0081] of the Development and Research Center, Ministry of Nuclear Industry: "Strategies and Measures for the Development of Nuclear Power in China" (manuscript received 26 December 1987)]

[Excerpts] Abstract: This article begins with the current world energy situation, prospects for developing nuclear power, demand for energy resources in building China's national economy, and the present situation in nuclear power development in China to analyze the necessity, urgency, and feasibility of developing nuclear power in China now. Moreover, it uses this as a foundation to propose strategies and measures for developing nuclear power in China.

Construction at the Guangdong Daya Bay and Qinshan nuclear power plant projects is proceeding according to plan, indicating an excellent beginning for developing nuclear power in China. Many experts in our policymaking departments and in energy circles, as well as experts in environmental protection, communications, social affairs, economics, and other areas have made their starting point the fact that China's economic centers are located in the east while our energy resource centers are located in the west and the fact that coal occupies the dominant position in our energy resource structure, and they have analyzed the serious effects caused by an energy structure centered on coal in China on environmental protection, the ecology, the atmosphere, communications and transport, and society. They have always felt that a basic solution to the problems caused by burning large amounts of coal requires transformation of our energy resource structure and development of clean new energy sources. Nuclear power is the new energy resource most suited to the development of the southeastern coastal region with its severe energy shortages and great distance from coal base areas. Through the joint efforts of all areas, the state now has made the development of nuclear power stations along China's southeastern coast a national policy, and the construction of these two nuclear power stations in China has received substantial cooperation and active support from all areas.

Nevertheless, some in China fear that it would be neither economical nor safe for China to develop nuclear power. This is especially true following the accident at the Chernobyl Power Station on 26 April 1986 which frightened the world and increased fears over the development of nuclear power. We feel that, in regard to the question of whether or not China should develop nuclear power, we should look at it in terms of a long-term energy resource development strategy and use the systems analysis perspective to evaluate the good and bad aspects of nuclear power and make an accurate scientific foundation the prerequisite for formulating strategies to develop nuclear power in China. In this article we will make an objective evaluation of the world situation in nuclear power development, a truthful analysis of the main issues in nuclear power development in China, and a preliminary comparison of the economy of nuclear power and thermal power, and finally offer some opinions on policies and measures for developing nuclear energy in China.

[passage omitted]

II. The Issue of the Need for a Unified Understanding of Nuclear Power Development in China

2.1 It Is Essential That China Develop Nuclear Power

The strategy for economic construction in China can be divided into three main steps. The first step is to double

our Gross Domestic Product compared to 1980 and solve the food and housing problems of our people. This task basically has been accomplished. The second step, up to the end of this century, is to again double our GDP and raise the people's living standards to the relatively well-off level. The third step, which will come during the 21st century, is to raise our per capita GDP to that of the moderately developed nations. When relative wealth is attained in the people's living standards, we basically will have achieved modernization. According to forecasts by the relevant concerns (see Table 1), to achieve this strategic goal, the rate of growth in energy demand will be very high.

Energy is the foundation of social and economic development, and China's four modernizations drive requires large amounts of energy. Table 1 shows that demand for commodity energy resources in China in the year 2000 will reach 1.4 billion tons of standard coal, and China will need about 3.5 billion tons of standard coal in 2030. The energy shortage has become a primary factor which restricts development of the national economy, and the electric power shortage is particularly acute. China now is focusing on energy construction centered on electric power. The nation has conscientiously made stronger electric power construction a focal point in economic development strategies with substantial achievements. Power output grew at an average yearly rate of 6.4 percent in China from 1981 to 1986 and the installed generating capacity of China's electric power equipment at the end of 1986 exceeded 93 million kW, with power output in excess of 440 billion kWh. In 1986, installed generating capacity grew by 11.2 percent and power output by 13.4 percent, but China still experienced an extreme energy shortage. Per capita power output in China was only 400 kW, just one-fiftieth of the largest electricity generating nations. Although China has rather rich reserves of conventional energy resources and a very large amount of absolute resources, we are not rich in per capita terms. China has only one-half the world per capita figure for energy resources, one-seventh the Soviet Union, and one-tenth the United States. We are third in the world in coal on the basis of proven reserves and tenth on a per capita basis. We are tenth in the world in total petroleum reserves but only 29th in per capita terms. China has 676 million kW in hydropower resource reserves, the most in the world, but only 379 kW is developable, and our per capita figure is only 81 percent of the world average. Not only does China have

Table 1. Projected Medium and Long-Term Economic and Energy Resource Demand Indices for China

Indicator	Year 1980	1985	1990	2000	2030
Gross National Product ($ billion)	273.6	459.7	660	1,203	5,199
Demand for energy (million tons of standard coal)	602	841	991	1,414	3,450
Demand for electric power (billion kWh)	300.6	407.3	550	1,200	5,186
Energy consumption per value of output ($\frac{\text{tons of standard coal}}{\$10,000}$)	22.0	18.3	15.0	11.8	6.6
Energy resources used for power generation as a proportion of total primary energy resources (percent)	20.6	19.3	21.1	30.5	49.5
Per capita GDP ($\frac{\$}{\text{person}}$)	277	439	593	962	3,710
Per capita annual energy consumption ($\frac{\text{tons of standard coal}}{\text{person per year}}$)	0.61	0.8	0.89	1.13	2.46
Per capita annual electricity consumption ($\frac{\text{kWh}}{\text{person per year}}$)	304	389	494	960	3,700

Notes:
1. Value of output calculated at 1980 prices.
2. At the time the projections were made, $1.00 = 1.55 yuan renminbi.
3. The 1990 figure is from the Seventh 5-Year Plan.

relatively small energy resource reserves on a per capita basis, but their geographic distribution is extremely uneven. About 80 percent of China's coal reserves are in the north. The four provinces and autonomous regions of Shanxi, Inner Mongolia, Shaanxi, and Ningxia contain 69 percent of our proven reserves. These four provinces and autonomous regions contain 76 percent of our remaining reserves, while only 2 percent is in the eight provinces of Jiangnan [area south of Chang Jiang]. More than 70 percent of China's hydropower resources are located in the southwest. The three provinces of Tibet, Yunnan, and Sichuan contain about 65.3 percent of our developable hydropower resources, and this hydropower will be rather hard to develop and utilize. Energy resources in the three large regions of east China, north China, and south-central China account for only about 15 percent of China's energy reserves. The energy reserves in a 13-province area which includes the eight provinces of Jiangnan as well as Shandong, Hebei, Liaoning, Jilin, and Henan account for only 13 percent of the national total, but they have 63 percent of China's population and account for 65 percent of our energy consumption. This is particularly true of the serious energy shortage in the Jiangnan region, which has formed an irrational situation in which China's economic centers are in the east while its energy resource centers are in the west.

To deal with the situation of an uneven distribution of energy sources, we usually have had to compensate by hauling northern coal south and transmitting western electricity east. The result is that energy resource shipments account for more than one-half of China's railway haulage and coal shipments account for more than one-third of water transport, causing severe communications and transportation shortages. In east China, for example, if we rely entirely only coal to provide the energy needed to quadruple the gross value of industrial and agricultural output, estimates are that almost 6 times as much coal will have to be shipped into the region by the end of this century. It is easy to see that providing sufficient energy resources will make it even harder to solve our transportation problems.

Although the state has made considerable efforts in all areas, an extremely serious energy shortage still exists in densely populated and industrially developed coastal regions and the provinces and municipalities of northeast China. The power shortage is particularly acute in rural areas of China now. Rural per capita electricity consumption is now 56 kW, less than one-fiftieth the figure in the Soviet Union. There also is a 40 percent shortage of power for agricultural electric motors. This has led to excessive cutting of firewood and an inability to return crop residue to fields, causing serious environmental damage.

Per capita energy consumption in China at present is much lower than the world average level. It is only one-fourth of the world average, one-eighth of Japan, one-tenth of the Soviet Union, and 1/20th of the United States. If the people of China wish to attain a relatively well-off living standard by the year 2000, a per capita electricity consumption figure of 1,000 kW would not be excessive. In the 21st century, as energy demand continues to grow, energy development in China must involve active exploitation of new energy sources and energy diversification, and we must accelerate the development of a renewable energy resource acknowledged worldwide as advanced and realistic—nuclear energy. Otherwise, China will have major problems with energy resource development, transportation, the environment, and industrial deployments. Solely on the basis of the current situation and forecasts up to the end of this century, demand for electricity in China will reach 1.2 trillion kWh, and energy resources used to generate electricity will account for 30 percent of total primary energy resource consumption. Growth trends from preliminary forecasts made by the relevant departments are shown in Table 2.

Table 2. Electric Power Growth Trends in China 1980-2000

Source	1980 Billion kWh	Percent	1990 Billion kWh	Percent	2000 Billion kWh	Percent
Coal-fired power	189.1	62.9	455	75.8	890	74.2
Oil-fired power	53.3	17.7	25.0	4.2	20	1.7
Hydropower	58.2	19.2	120	20.0	260	21.6
Nuclear power	—	—	—	—	30*	2.5
Total	300.6	100	600	100	1,200	100

*Total installed generating capacity from nuclear power of about 5.5 million kW

The demand projections in the table are minimum limits, and it is very possible that these forecasts may be exceeded by 2000. If arrangements must be based on these minimum limits, coal-fired power must increase to 890 billion kWh. If we calculate on the basis of coal-fired power consuming 350 grams of standard coal per kWh, it will take about 500 million tons of raw coal each year. Data from current state forecasts show that the amount of coal which the nation can provide for power generation cannot exceed 400 million tons, which means that at

a maximum coal-fired power cannot exceed 740 billion kWh. It is apparent that, even if we ignore transportation, environmental protection, and other serious problems which may be encountered, and develop coal-fired power excessively, there will be no way to achieve this because of inadequate coal supplies, so we must strive to develop hydropower and nuclear power to the greatest possible extent. In developing electric power in China, taking into consideration a 7 percent yearly growth rate in power output, electricity output in China must reach 3 trillion kWh by 2015. The projected electric power production structure is 1.8 trillion kWh from thermal power and 300 billion kWh from hydropower, with the two totaling 2.1 trillion kWh. If nuclear power can grow to an installed generating capacity of 30 million kW by 2015 and generate 180 billion kWh of electricity, we still will have a 720 billion kWh shortage which must be compensated. This shows the enormity of the power shortage in China! It would seem that the most reliable way to make up this shortfall is active development of nuclear power.

Industry now consumes more than two-thirds of China's energy and more than 70 percent of the energy resource structure comes from burning coal. This should receive special attention in future energy development plans and we should adopt measures to change it gradually. The situation in China and foreign countries also has shown that transportation and environmental pollution will be the most important factors which restrict the amount of coal utilized. Direct burning of large amounts of coal would cause serious acid rain phenomena and the greenhouse effect, which in turn would lead to further degradation of the already severely degraded environment, perhaps to an intolerable extent. To solve these problems, we must gradually change the existing energy resource structure. With the environmental needs man depends on for his existence, progress in science and technology, and the continual decrease of energy resources, a shift in the energy structure from fossil fuels to diversification is an inevitable trend. Because nuclear power is technologically mature and economically competitive, and because of the great energy density of nuclear fuels, the small amount of fuel shipments, and the limited amount of environmental pollution, it is seen by most nations of the world as a prospective renewable energy resource.

China does not just have an energy shortage. We also have a substantial shortage of raw materials for the chemical industry. The development of nuclear power also could replace large amounts of coal and oil for use as a chemical industry raw material for intensive processing. This would be very important for economic development, meeting the living needs of the people, and rational energy resource utilization.

In summary, by beginning with the actual situation in China's energy resources, communications, transportation, and the environment, we must develop and utilize nuclear energy to assure sustained and stable development of China's economy.

2.2 The Nuclear Power Development Situation in China and Plan Goals

Based on trends in world energy resource development and energy demand and development in China, central authorities made the timely proposal of the principle that China actively develop nuclear power in a suitable manner. China's electric power policy is to combine a major effort to develop thermal power and actively exploit hydropower with the focused, gradual, and appropriate development of nuclear power. Nuclear power has just gotten under way in China, large investments are needed for nuclear power construction, schedules are long, technologies are complex, we lack experience, and the state's financial and material abilities also are limited at present, so we cannot develop it on a large scale in the near term. However, we also must take action in a focused manner to develop it gradually and make nuclear power supplement China's energy sources. Nuclear power certainly can be a supplement on a national scale, but it can gradually become the energy pillar of the electric power industry in the densely populated and industrially developed coastal provinces and municipalities and the regions of northeast China which have serious energy resource shortages and consume large amounts of energy. Although nuclear power will account for only a small proportion of China's energy resource system during this century, it is extremely important that we make an excellent beginning. One important goal in proper development of nuclear power now is to grasp the advanced technologies involved in nuclear power construction to make technical preparations and build staffs for major development of nuclear power in China during the 21st century. It should be noted that the quantity and pace of nuclear power development in China before 2000 will restrict the development of nuclear power after 2000. Thus, the rate of development now should consider the long-term needs of the energy resource system. China is a socialist nuclear nation, we joined the International Atomic Energy Organization in 1984, and we have been recommended as an appointed member state on the board of directors of this organization. Moreover, we have signed agreements with several nations on the peaceful uses of nuclear energy and we should walk in the front ranks of the world in atomic energy and the area of peaceful utilization.

China began considering the question of nuclear power construction in the mid-1960's, which at the time mainly involved conducting some survey research. Just as we were beginning to become involved in research and design of nuclear power plants from the engineering side, the 1970's began. Later, because of interference by the "gang of four," and with the added effects of the accident at Three Mile Island in the United States in 1979, nuclear power construction never really got under way in China.

After the 3d Plenum of the 11th CPC Central Committee, the central authorities began to suggest that the nuclear industry "guarantee military needs while shifting

to civilian uses," and they later clarified the principle of gradually establishing a new system to integrate military and civilian uses. In 1983, we also decided to accelerate the development of nuclear power. Next, the State Council established its Nuclear Power Leadership Group to strengthen leadership over development of the nuclear power industry in China and formulated several principles and policies for the development of nuclear power. For example, they selected the pressurized water reactor as the primary reactor type for nuclear power stations, stipulated that nuclear power construction in China should focus on reliance on our own efforts in conjunction with importing advanced technologies from foreign countries, assimilating advanced technologies imported from foreign countries and then gradually shifting to domestic production by "focusing on China, with Chinese and foreign cooperation," basing nuclear fuels on domestic supplies, and so on.

Nuclear power construction has just gotten under way in China, and the overall situation is good. At the Qinshan 300,000 kW pressurized-water reactor nuclear power station which China designed, developed, and built itself, construction of the main body of the reactor core is now being speeded up and the plan is for it to be completed and produce electricity in 1990. At the Daya Bay Nuclear Power Station, where the entire facility was purchased from abroad and is jointly managed with Hong Kong, the power will be 2 x 900,000 kW and the prediction is that it will be completed, connected to the grid, and begin to generate electricity in 1992-1993. Moreover, preparations are now under way for the 2 x 600,000 kW generators in the second stage of the Qinshan Power Plant.

The most promising new energy source is a nuclear energy development sequence from thermal neutron reactors to fast neutron breeder reactors to controlled thermonuclear fusion reactors. After the accident at the Chernobyl Nuclear Power Plant in the Soviet Union, China's national leaders also pointed out several times that China's principle of developing nuclear power had not changed and that China's plans to develop nuclear power were formulated on the basis of world energy resource development trends and China's national conditions. China has the technical capacity to develop nuclear power now, and we have certain favorable conditions. Of course, we lack experience in building and operating nuclear power plants, so we have invited experts and scholars from nations with advanced nuclear power to provide advice during our design and construction over the past few years and we have sent several middle-aged and young S&T personnel to nuclear power plants in foreign countries for training and study. If we can make full use of our existing foundation and do good planning and organization work and then grasp nuclear power technologies and train technical staffs by building the Qinshan and Daya Bay nuclear power plants, with China's existing foundation and joint cooperation by the relevant departments in China, we can study and borrow from positive and negative lessons in foreign countries, strictly adhere to Chinese regulations and laws regarding nuclear safety management, and conscientiously adhere to the principle of safety first and quality first, we can assure that China's nuclear power industry moves forward in a safe, economic, healthy, and stable manner. Of course, it must be solemnly pointed out here that nuclear power development and construction in China is at a crucial stage because we will no longer be able to seize this valuable opportunity and push China's nuclear power industry forward. China's advantages in the area of developing nuclear power would gradually be lost and nuclear industry equipment would become outdated. Existing nuclear S&T personnel would grow older and drift away, and there would be no way to train a new generation of nuclear S&T personnel. If we fail to lay a good foundation for the nuclear power industry in this century, building nuclear power will be even harder in the 21st century. If we do this, it would assure hard-to-compensate losses in the areas of nuclear energy and its peaceful uses in China.

In developing nuclear power, if we continue resolutely according to arrangements in existing preliminary plans, China's nuclear-powered installed generating capacity could reach 3.3 million kW and yearly power output could be 20 billion kWh. The yearly value of output would be 2 billion yuan, and its social benefits would be even greater. The period from now to 1995 is the key stage in China's gaining a grasp of nuclear power technologies, and the completion and startup of the power plants mentioned above will lay a solid foundation for further design and construction of domestically produced nuclear power plants in China. By preparing this condition, China could build another group of 600,000 kW nuclear-powered generators before 2000 and fully achieve the capacity to produce 600,000 kW nuclear powered generators in China. At the same time, by assimilating large-scale nuclear power plant technologies and actively creating the conditions for domestic production of large nuclear power plants, it would be possible to build one or two 1 million kW nuclear power plants in the late 20th or early 21st century. The period from 1996 to 2005 is the stage of stable development of nuclear power construction in China. At that time, because China will have a grasp of the technologies for nuclear power plants and will have a nuclear industry on a substantial scale, it would be possible where conditions permit to focus on developing large domestically produced nuclear power plants to increase economic benefits. The period from 2005 to 2015 is the stage of major development of nuclear power in China. At that time, China will have reached the stage of domestic production, standardization, and systemization of thermal neutron nuclear power plants, and will have begun working on fast neutron reactor nuclear power plants. We can build another group of nuclear power plants based on the deployment of national economic development and energy demand.

Based on the above ideas and plans, it would be realistic to have the two-step nuclear power construction goal of

building a total of 6 to 7 million kW in installed generating capacity before 2000 and completing about 30 million kW by 2015.

III. The Comparative Economy of Nuclear Power and Thermal Power

Although nuclear power has revealed its superiority in many nations, what worries everyone about nuclear power is the high construction costs and long construction schedules. For this reason, the economy of nuclear power, particularly in regard to the development of nuclear power in China, is something that continues to worry some people. This is understandable, and it is a question which requires discussion and clarification.

A nuclear power plant is a technologically intensive project and there are inherent risks in its operation. For this reason, there are strict regulations concerning equipment manufacture and installation which lengthen the corresponding construction schedules. In general, they take about 2 years longer than thermal power plants of equivalent capacity. A principle of investment dynamics analysis is that longer construction schedules lead to greater manufacturing costs, so nuclear power plants cost more to build than coal-fired power plants. On the basis of proportional investments (manufacturing cost per kW), nuclear power internationally generally is about 50 percent higher. The situation varies in each country, however. France has the greatest degree of standardization in nuclear power and the cheapest manufacturing costs, only 1.23 times the cost of coal-fired power. The figures are 1.41 times in Japan, 1.77 times in Italy, and 2 times in West Germany.

The two nuclear power plants China now is building required much greater proportional investments than coal-fired power plants. Some have suggested that proportional costs in the Guangdong Nuclear Power Plant are 5 to 10 times higher than coal-fired plants. Actually, analyzing the concrete conditions and costs of power plants permits deriving a more objective conclusion. The Qinshan Nuclear Power Plant is the first designed by China itself. It is a prototype nuclear power plant in which most of the equipment was manufactured in China, so the cost includes technical transformation expenses in equipment manufacturing plants. The Guangdong Nuclear Power Plant is another project which was imported under special conditions. For this reason, the comparative costs of these two nuclear power plants are higher than the usual cost internationally, which also is rather natural. However, it certainly is not 5 to 10 times higher than coal-fired plant. Comrades who hold this opinion have underestimated the cost of China's existing coal-fired power plants since the comparative investment in coal-fired power plants they use is 800 yuan, the old cost. Actually, the scale of investments which the state made to develop coal-fired power during the Seventh 5-Year Plan was adjusted to 1,300 yuan per kW. Moreover, the design budget generally exceeds this figure, and based on the usual experience, actual construction costs often exceed indices in design budgets. Moreover, the cost of thermal power plants in China does not include investments in the environment, transportation, and other related areas. For environmental protection alone, things like the additional desulfurization facilities raise the cost per unit kW by about 25 percent. There also are major differences in fuel shipment between these two types of power plants. At a 1 million kW grade nuclear power plant, for example, only about 30 tons of nuclear fuel must be replaced annually, whereas a thermal power plant of equivalent capacity requires shipping 3 million tons of coal over long distances each year. For this reason, the cost of a coal-fired power plant should include additional expenses allocated for railways, locomotives, and ports. It is quite obvious that, after these essential expenses are added to the operating costs of thermal power plants, investments in nuclear power plants are not several times higher than thermal power plants.

As for the related investments at thermal power plants, particularly the costs of transportation, some have used the method of dividing costs used in China and foreign countries and proposed that we only calculate fuel costs and not consider the related investments, because that there is no reason to do so. However, it must be noted that China basically has retained the same energy resource prices for 30 years and that the price of coal is much too low, which is an extremely acute problem. The cost of producing a ton of coal rose to 21.97 yuan in 1982 but coal prices rose only to 20.6 yuan despite three readjustments, so coal departments have suffered losses for years. If we make economic comparisons using this kind of price which is detached from the law of value, it inevitably will create false impressions which could lead to entirely mistaken conclusions. For this reason, we fully agree with the systematic comprehensive comparison of investments made by many experts in China. The nearly identical conclusion of these comparisons is that the difference between building commercial nuclear power plants in coal-short regions of China and coal-fired power also conforms to common rules internationally.

Besides their concern for investments in nuclear power plants, people also are worried about the ultimate cost of generating power.

The common rule is that nuclear power plants have higher basic costs and involve longer construction schedules than thermal power, so how could generating power with nuclear energy cost less than coal-fired power? To answer this question, we first of all analyzed the structure of power generation costs, with the costs usually including recovery of the investment, fuel costs, operating and management costs, maintenance costs, and so on. A large amount of statistical data from China and foreign countries shows that recovering construction costs accounts for 60 percent of nuclear power costs

while fuel costs account for only 20 percent. The structure of costs for coal-fired power is exactly the opposite, with fuel costs accounting for 55 percent and investment recovery for only 38 percent. This makes it easy to see that as the commercial operating time of nuclear power plants increases, power generation costs at nuclear power plants undergo an obvious decline as the proportion for investments in the total cost structure declines. This is not the case in coal-fired power plants because fuel costs play the dominant role from beginning to end. For this reason, the average cost of power generation over the economic lifespan of these two types of nuclear power plants makes nuclear power cheaper than coal-fired power, which is the inevitable result.

IV. China Has the Preconditions To Develop Nuclear Power

China has already built a rather complete system for the nuclear industry, nuclear scientific research, and nuclear technology applications which few nations of the world have. First, in the area of uranium resource development and utilization, we have established a fairly complete nuclear fuel cycling system for uranium ore extraction, uranium concentration, nuclear fuel element manufacturing, reprocessing, and so on. For several years, China has been engaged in aerial surveys and ground prospecting, and we have discovered a substantial amount of uranium resource reserves. Moreover, we have established water dressing, concentration, and element manufacturing plants on a substantial scale. In developing the "two bombs" [atomic and hydrogen], these plants and mines have gradually perfected production conditions and accumulated rather rich practical experience.

Second, in the process of developing the military nuclear industry, China has formed a complete nuclear technology scientific research system, and we have built over 10 reactors, including research reactors, experimental reactors, production reactors, nuclear-powered equipment, and others. We also have accumulated more than 170 reactor years of operating experience. China also has built more than 10 accelerators of various types, and few nations of the world have Tokamak controlled nuclear fusion research facilities. We also have built the No 1 Cyclotron and taken the first step in opening up the realm of nuclear fusion.

Third, beginning in the 1960's, China's machine manufacturing industry has provided the nuclear industry with large amounts of special-purpose reactor equipment including military production reactors, nuclear powered submarine reactors, high flux engineering experimental reactors and other key state projects. In the area of new materials development, the relevant departments also have done a great deal of work and now are able to produce some materials. This is particularly true for China's own design for construction of the Qinshan 300,000 kW nuclear power project, for which most of the equipment was manufactured in China. China now basically has the foundation and capacity to build large and medium-sized nuclear power equipment for pressurized-water reactors.

Fourth, during the process of more than 30 years of development, the stimulus of the spirit of working hard to make the country strong and building an enterprise through arduous effort has led the nuclear industry to create a formidable and victorious workforce of 300,000 people and concentrated a group of high and mid-level key S&T cadres with good political qualities and high professional standards. During their many years of service to the military, they have formed an extremely rigorous working style and accumulated rich experience. Combined with the favorable conditions of China's having opened up to the outside world in the past few years, they have been able to absorb a wide range of advanced technologies from foreign countries and their experience in building the Guangdong and Qinshan nuclear power plants has gradually matured this nuclear S&T workforce in the area of the development and utilization and nuclear power. This is an important force for the development of nuclear power in China.

Fifth, another important point is that the development of nuclear power in China has always received the attention of our national leaders. As early as 8 February 1970, Premier Zhou Enlai clearly proposed that China develop nuclear power. The alternate name of the "728" project for the Qinshan 300,000 kW nuclear energy project was given to commemorate this day. After the 3d Plenum of the 11th CPC Central Committee, the central authorities again raised the question of nuclear power construction and after a period of deliberation and debate, Premier Zhao Ziyang systematically suggested principles for nuclear power construction in China. The two nuclear power stations now under construction immediately received attention from central leaders, particularly after the accident at the Chernobyl Nuclear Power Plant in the Soviet Union in April 1986. China's leaders formally announced that China's nuclear power development policies would not change. The farsightedness of our national leaders has provided a strategic viewpoint for mankind's energy resource supplies.

In summary, whether we are speaking of China's resource conditions, the foundation of nuclear technologies, or levels of China's conventional industries, as well as the degree of national concern, they all illustrate fully that China has the conditions to develop the nuclear industry, that we can believe that China is entirely capable of taming nuclear power, and that it will play an increasingly important role in China's economic development.

V. Countermeasures and Measures for Developing Nuclear Power in China

Although China's nuclear power construction has an excellent starting point, many problems remain to be solved. For example, China has no long-term nuclear

power development plan and no firm decisions have been made about the scale of nuclear power development. There are no regular capital channels for nuclear power construction and expenditures on research in the nuclear sciences have been reduced time after time. No measures have been implemented to shift to domestic production of nuclear power equipment. Systems to regulate nuclear power construction are incomplete, and so on. All of these questions deserve study and treatment.

After studying the actual situation in nuclear power construction in China and absorbing the opinions of the relevant experts, we offer the following suggestions:

1. Include nuclear power construction in state energy resource development plans

One reason for the slow pace of nuclear power development in China and in the past is that nuclear power has never truly been included in state energy plans and nuclear power policies have wavered, causing us to lose valuable time.

The scale of nuclear power plant construction is one of the main factors which affect the economy of nuclear power. If we are unable to achieve domestic production in large quantities, there will be no way to reduce the costs of nuclear power plants. According to our calculations, if we fail to complete 6 to 7 million kW of nuclear power plants during this century and do not form the capacity to produce one or two sets of nuclear power equipment annually in China, it will be impossible for China to form an economic nuclear power equipment production line, and there will be no need to discuss the economy of nuclear power. Gaining nuclear technologies will be difficult without a definite construction scale. Thus, we should make building nuclear power plants on a definite scale an important consideration when formulating nuclear power plans.

We propose that the State Planning Commission join with other departments and commissions to organize experts to conduct survey research and formulate long-term development plans and short-term plans for nuclear power in China as quickly as possible. These plans should become part of state long-term energy development plans.

2. China must have stable nuclear power development policies

International experiences have shown that nuclear power has developed quickly in all nations with stable nuclear power development plans, and the economic benefits are rather apparent. The Soviet Union has adhered to a principle of building nuclear power plants only in its European part, and it has found an excellent outlet to optimize its energy resources by solving the electric power shortage in its European part which is industrially developed but far from coal base areas. Its major effort to develop nuclear power has provided the Soviet Union with economic benefits worth more than 1 billion rubles. After the profound shock from the Chernobyl nuclear accident, the government of the Soviet Union continued to develop nuclear power and the pace of nuclear power development has not slowed. France also has been resolute in developing nuclear power and may achieve energy independence sooner than expected.

China's nuclear power development policies have been affected by the international climate. In 1983, we were influenced by Toffler's third wave propaganda about new energy sources replacing nuclear power and nuclear energy was censured in China. Later, when Director Brown of the World Watch Research Institute visited China, he encouraged the idea of eliminating nuclear energy and nuclear power was again derided in China. These things affected the state's decision to develop nuclear power.

We propose that, given the geographical imbalance of China's energy resources and the serious power shortage in the rapidly developing economy of our southeast coast, we should confirm the strategic status of nuclear power in long-term stable energy supplies in China and make nuclear power development a national policy. China must have a stable policy for development of nuclear power.

3. Achieve good cooperation among all departments, strive to cooperate in building nuclear power plants

Experience has shown that because the nuclear power industry is a very comprehensive industry which involves many departments and sectors, industrial departments must cooperate in nuclear equipment, nuclear fuel, machinery, electronics, metallurgy, materials, and other fields to complete construction tasks. Nuclear power construction in China is only in the initial stages, and the two nuclear power plants now under construction have a rather high cost, each for their own reason. Thus, all areas must work together to reduce the costs of nuclear power. Past experience in the maturation of industries has shown that cooperation and assistance from all departments can save on construction costs. In contrast, if the cooperating units have the ideology of getting everything they can ["chidahu" [0676 1129 2073]—mass seizure and eating of food in the homes of landlords during famines before liberation], the cost of construction may rise substantially. If costs are not controlled, nuclear power may lose its economic competitiveness and nuclear energy construction would be in danger of premature death in China.

Now, the State Council has established the Nuclear Power Leadership Group, and its leadership and coordinating role should be reinforced. This group should take responsibility for the final formulation, examination, and implementation of medium and long-term nuclear power plans, and it should formulate policies for the development of nuclear power in China and coordinate

actual questions in the construction of nuclear power plants. At present, all departments should strive to cooperate under the unified leadership of this group and assure both quality and quantity in completing construction tasks involved in building the two nuclear power plants under construction on schedule.

4. Establish regular investment channels, adopt the self-development principle of "using nuclear power to develop nuclear power"

Internationally, all nations with developed nuclear power provided state capital assistance and adopted special supporting policies during the initial stages of nuclear energy development. They waited until after nuclear power plants became commercialized before turning them over to industrial companies for management. The United States, for example, spent over $40 billion for R&D, and these costs were included in total state expenses for energy R&D.

Given China's national conditions, nuclear power is an emerging electric power industry in China and its foundation is rather weak. It also is an industry which we should strive to develop, so we must implement slanted [preferential] capital policies for nuclear power, raise selling prices appropriately, and implement the principle of "using nuclear power to develop nuclear power." Only by using nuclear power to accumulate its own capital to build more nuclear power can we solve the nuclear power investment and nuclear power development problems.

The relevant departments and experts feel that two programs can be chosen:

The first program is for the state to allocate an 8 billion yuan nuclear power development fund for the period 1988 to 1997 to build several nuclear power plants, without requiring repayment of the principal or interest. This way, one 600,000 kW nuclear-powered generating unit could go into operation each year beginning in 1995, and a development fund could be accumulated from the yearly income from electricity fees after they go into operation. The electricity produced by nuclear power would be sold at the same price as the power produced via capital raised by the China Power Company. Each kW would be sold to users for 0.20 yuan, with 0.025 yuan/kW deducted from this amount for fuel costs, 0.01 yuan/kW for operating and maintenance costs, and 0.015 yuan/kW for power line losses and management expenses, and it would include a 3 percent product tax. The remainder would be retained for a nuclear power development fund. In this way, each 600,000 kW nuclear generating unit could accumulate a 450 million yuan nuclear energy development fund annually. Beginning in the year 2000, nuclear power would have the capacity for self-development.

The calculations were made according to the base price for 1 January 1987. They should be readjusted when the state allocates the funds for price fluctuations and currency rate changes and the price of electricity should be readjusted for price fluctuations.

Until nuclear power is capable of self-development, the state should continue to provide matching funds for nuclear fuel cycling related to nuclear power construction. The state can continue to provide allocational support through existing nuclear power R&D expense channels and funds for nuclear power plant retirement and reprocessing until 2000. After nuclear power stations have operated for 15 years, accumulations can be deducted from electricity fees each year.

The second program is for the state to provide low interest loans at 2.4 percent to the nuclear industry. The nuclear power would be sold to subscribers for 0.20 yuan/kW and there would be a 5 percent product tax on the nuclear power. As in the other case, a nuclear energy development fund would be deducted from income from electricity sales, and there would be specific and broad-range time limits for repaying the principal and interest. After completing several million kW of nuclear power plants, we would achieve self-sustained development by "using nuclear power to develop nuclear power."

The state should organize experts to debate and then choose which of these methods actually is most suitable.

5. Use the spirit of reform to optimize each link in nuclear power construction, fully exploit potential, conserve investments, and improve results

Nuclear power plants are capital intensive and technology intensive, and they involve large scales and long construction schedules. All of these factors are unfavorable to competition with conventional thermal power plants. Thus, during nuclear power project construction, attention should be given to optimization.

First, we should absorb lessons from the past of attempting small-scale energy construction projects and strive to build the existing Qinshan and Daya Bay nuclear power plant sites into multi-reactor nuclear power plants and save investments. We should avoid building nuclear power cities [excessive new construction] and carrying millstones [burden of new facilities] by making full use of existing facilities in towns near nuclear power plants to establish nuclear power production and employee living base areas.

Nuclear power plant construction projects should solicit open bids from China and foreign countries, and they especially should implement sub-project bidding to select the best units for responsibility.

6. Adopt effective measures for strict control of quality, progress, and costs in the two nuclear power plants now under construction

Equipment, construction, and installation quality at nuclear power plants determine the safety and economy of nuclear power. We must establish a top-to-bottom quality assurance concept and complete quality assurance system. We should import advanced quality control and experience from foreign countries, establish and perfect a nuclear power quality assurance system for China, and implement a job responsibility system. Responsibility should be sought for dereliction of duty, and economic compensation and legal responsibility should be sought in serious cases.

Time is money in nuclear power plant construction and a 1-day delay in startup of a large nuclear power plant causes a loss of more than $1 million. We must avoid emphasizing hardware while neglecting software, emphasizing design while neglecting purchases, and erroneous tendencies which affect progress. We must establish strict project management systems, set up systems for equipment purchasing, handover, takeover, and advance expediting, and implement the required reward and punishment systems to assure project progress.

There may be a loss of control over costs at the two nuclear power plants now being built, so we propose that the relevant departments earnestly study this question and adopt truly feasible cost-control measures.

The success or failure of the two nuclear power plants now under construction concerns the future and fate of nuclear power development in China. All departments must strive to coordinate and build these two nuclear power plants on schedule with assured quality and quantity, establish models, and accumulate experience for developing nuclear power in China.

7. Adopt measures to accelerate the shift to autonomous decisionmaking in nuclear power plant construction and domestic production of equipment supplies

Experience has shown us in building our first nuclear power plant that the cost will always be higher if we import complete sets of equipment and technologies from foreign countries. To reduce the cost of building nuclear power plants and increase nuclear power's competitive ability, we must work to speed up the shift toward autonomous decisionmaking in nuclear power construction and toward domestic sources of equipment supplies.

Autonomous decisionmaking in project design and management is easier to achieve and produces faster results than domestic equipment production, and it is a prerequisite for domestic equipment manufacturing. Now, we must correct the erroneous tendency of the past which focused only on equipment manufacturing technologies while neglecting project design and management, and accelerate the shift to autonomous decisionmaking in project design and management.

Later, while continuing to build nuclear power plants, the state should formulate proportions for domestic production according to China's industrial foundations and actual manufacturing abilities, and quotas for domestic production should be set as hard project indicators. The sequential arrangements for a shift to domestic nuclear power equipment production should be deployed scientifically according to technical difficulty and domestic capabilities, with distinctions made between slight and great urgency. Auxiliary equipment in nuclear power plants is less technically difficult, and it accounts for about 60 percent of the total investment. The technical complexity of the primary equipment (main pumps, pressure vessels, steam generators, etc.) is greater, but they account for only about 40 percent of investments. Thus, the shift to domestic sources in equipment manufacture should begin with auxiliary equipment. This would make it easy to understand the technologies and save considerable foreign exchange in the investment.

Our proposed countermeasures and measures for building nuclear power in China are just principles. The problem we face now is that, with a precondition of acknowledging that China must develop nuclear power, we should earnestly study how to cheaply and proficiently build a nuclear power industry with Chinese characteristics. Taking China's national conditions as the starting point, we feel that the sooner we build nuclear power plants in China, the sooner we will obtain benefits and solve problems of supplying high quality energy to the economically developed and severely power-short regions of our southeast coast. Imbalanced economic development is not just something found between nations or between regions. It is instead an unavoidable developmental law in China, both now and in the future. Some have advocated economic migration in China in the past, but the facts have shown that this idea is not possible. An economic takeoff in all of China is impossible without guaranteed supplies of energy resources and raw materials in the economically developed and technologically advanced southeastern coastal region to allow it to exploit its potential fully, produce more high quality products, and support the entire nation. Nuclear power is best suited to the development of the technologically intensive southeastern coastal region with its enormous economic might. If nuclear power is to serve as a superior energy resource, it must occupy a definite position in our national energy structure, particularly in the economically developed southeastern coastal region.

Canadian Experts Say Three Gorges Project Feasible

40100019a Beijing XINHUA in English 1230 GMT 24 Nov 88

[Article by Fu Pingping]

[Text] Beijing, November 24 (XINHUA)—A panel of Canadian engineers involved in the feasibility studies of the controversial proposed Three Gorges project say that the project is both "feasible and financially viable."

Keith Webb, general manager of the Canadian International Project Management—Yangtze Joint Venture (CYJV), said that the project is "an attractive solution to reducing flooding and improving navigation on the Yangtze, and will be a new major source of renewable energy."

Webb said that comparisons were made between the Three Gorges project and 27 other proposed projects during the studies, and "there is no practical alternative which will achieve the same level of flood protection in the middle reaches of the Yangtze."

The project's general manager made these remarks during a recent exclusive interview with XINHUA.

The joint venture, backed by five Canadian Government agencies and private companies, began what Webb describes as their "independent and bankable" feasibility studies on the project in March 1986 as a result of an agreement signed by the Canadian and Chinese Governments.

During the past two years, more than 130 engineers, scholars and technicians have studied all the background material provided by China, and made 190 trips to the proposed site of the project and other relevant places before they felt satisfied with their conclusions.

The project recommended by Canada is a dam with a crest level of 185 meters (m), which is the same as the level proposed by the Chinese. However, the normal pool level of 160m they recommended is different from what the Chinese proposed: 156m in the first stage and 175m in the second.

The Chinese want a higher water level than the Canadians to accommodate large cargo ships, but the Canadians hold that the cost of resettling additional residents as a result of the higher water level will reduce the economic benefits of the project.

According to the general manager, aerial surveys and several on-the-spot investigations were made before they were convinced that all the people could be properly resettled.

"We are satisfied that you can resettle 727,000 people, provided that all the plans are properly coordinated, and the government ensures proper resettlement is carried out," he said.

He also expressed his confidence that the sedimentation problem could be solved.

When asked about environmental problems, he said the project is "environmentally feasible provided the recommended monitoring program is implemented."

Webb said that "the overall environmental impact of the project is less significant than the effects of alternative options, such as thermal power generation—which would have far-reaching implications for the environment."

The Canadians estimate the project would cost 24.6 billion yuan (in mid-1987 yuan) including the cost of resettlement, or 39.8 billion yuan with price increase taken into consideration during the construction period.

Webb stressed that by world standards, the project is a "very economical and very favourable hydroelectric power project, in terms of the financial rate of return and economic benefits."

He pointed out that "in all the assessments we've made, we haven't included the benefits to flood control and navigation that will be derived from completing the project."

"If you add those factors, it becomes all the more economic," he added.

Webb said that the entire study was monitored by a steering committee formed by China, Canada, and the World Bank, and advised by a panel of international experts.

He also mentioned that the final Canadian feasibility studies have been compiled and will soon be sent to the Chinese Government for reference, in making its final decision on the construction of the project

Three Gorges Project Said Key to Chang Jiang Development

40100019b Beijing XINHUA in English 0255 GMT 26 Nov 88

[Article by Fu Pingping]

[Text] Beijing, November 26 (XINHUA)—Located in a favorable position, with very good conditions for construction and the promise of enormous benefits, the Three Gorges project is a key one in the comprehensive development of the Yangzi River valley.

This is the conclusion reached by a panel of experts conducting feasibility studies on comprehensive planning and operating pool level after summing up all the conclusions made by sub-committees of other experts.

A report on the studies is being examined at the ongoing enlarged meeting of the feasibility studies board.

The panel, consisting of six consultants and 35 experts (including all the heads of sub-committees), spent two years on the study of the layout of the Yangzi River valley and the strategic role of the Three Gorges project. They also compared the project with other alternative plans before they produced their final report.

They agreed that the project can effectively reduce flooding along the middle and lower reaches of the Yangzi; provide central and east China with a powerful, steady and low-cost electricity supply; and improve the navigation channel and accommodate large cargo ships.

They pointed out that a great deal of work has been done in developing hydropower resources on the river since the founding of New China in 1949.

Now, a comprehensive plan with 11 subdivisions has been formed. It includes flood control, hydropower development, irrigation, navigation, water and soil conservation, and plans for 19 main stream and tributary projects.

Some experts and scholars insisted that the comprehensive development of the Yangzi River valley should place stress on the development of small and medium-sized projects on the upper reaches, which will cost less and have quick economic returns.

But the majority of the experts involved in the feasibility studies hold that the Three Gorges and other projects on the upper reaches are complementary, and that all of them should be built at the proper time when conditions permit.

These experts also pointed out that most of the projects on the upper reaches are mainly for power generation. Their benefits as regards flood control and navigation of the middle and lower reaches are restricted because they are located in distant areas and are comparatively small in size.

In order to further confirm the economic benefits of the Three Gorges project, the panel also drew up two comprehensive alternatives. But the results showed that none of them would be able to achieve the same effects.

The operating water level plan proposed by the panel consists of a dam with a crest height of 185 meters, and a normal pool level of 156 m in the first stage and 175 m in the second.

They said that the proposed water level plan can basically satisfy the needs of flood control, navigation and electric power generation; storage of water in two stages can relieve the difficulties of resettlement, provide a period for observing and examining the sedimentation problem and ensure early economic returns.

However, some experts on the panel don't agree with the majority. They have suggested that the Three Gorges section should be developed in two stages, and some regard 160 m as the optimum pool level.

Three Gorges Power Would Forestall Future Energy Crunch

40100019c Beijing XINHUA in English 1459 GMT 23 Nov 88

[Text] Beijing, November 23 (XINHUA)—Some power experts here hold that, judging by the potential power benefits and the country's energy situation, construction should start as soon as possible on the proposed Three Gorges project.

The experts, involved in feasibility studies on the subject over the past few years, said that the project is of great significance at this time when the country's energy supply is lagging well behind demand and coal transportation is suffering great difficulties.

At a water level of 175 meters for the Three Gorges dam, generators with a total capacity of 17.68 million kilowatts could be installed to produce an average of 84 billion kWh of electricity annually.

Located in the central part of the country, the Three Gorges project would be the nearest huge power source to the energy-short eastern regions. Shanghai, China's major industrialized city on the estuary of the river, is about 1,180 kilometers away.

Since the 1970s, China has been suffering a serious electricity shortage. In 1987, the total installed capacity exceeded 100 million kilowatts and power generated approached 500 billion kWh. Both increased by 10 percent over the previous year.

However, the country still lacks 70 billion kWh of power, or 15 million kilowatts of generating capacity.

As a result, many factories and enterprises have to limit or stop their production from time to time and the country's economic development, with the east and central part in particular, has been greatly affected.

The east China region, comprising Anhui, Jiangsu, Zhejiang, and Shanghai, is the country's most economically developed region, but it is relatively poor in hydropower resources and coal reserves. And affected by limited railway transport capacity, economic development in the region has been badly restricted.

The central China region, which consists of Hubei, Henan, Hunan, and Jiangxi, has some hydro resources. But most of their coal needed by thermal power plants are also imported from Shanxi or Shaanxi Provinces. Their production, too, has been threatened by the increasing shortage of power supply.

Altogether, the two regions now have a bit over 150 billion kWh of electric power. Experts said that problems will be all the more severe if the Three Gorges project is not built, as statistics show that by the year 2000, the two regions will need 500 billion kWh of power and 1,000 billion kWh by 2015.

They suggested that while striving to increase the transport capacity and further develop coal resources, efforts should also be made to develop hydro resources and construction of nuclear power plants should also be put on the agenda.

They insisted that the Three Gorges project, with a large installed capacity and a great deal of low-cost power, will provide a most effective and economic solution to the problem.

According to the plan, the first unit of generators of the Three Gorges project will turn out electricity 12 years after the start of construction. Each of the subsequent 6 years will see an increase of 2.72 million kilowatts put into operation.

The project's economic benefits will be similar to seven thermal power plants with a capacity of 400,000 kilowatts each, a coal mine with an annual capacity of 40 million tons, or two 800-kilometer-long railway lines.

Experts Gather To Assess Three Gorges Feasibility Study Data

40130038a Beijing RENMIN RIBAO in Chinese 2 Dec 88 p 3

[Dispatch by reporter Wang Yantian [3769 1750 3944]: "Experts Discuss Feasibility of Three Gorges Projects"]

[Text] The feasibility studies on the Chang Jiang Three Gorges Project lasting more than 2 years and 3 months have been basically completed. From 21 to 30 November, about 200 experts gathered at Beijing for the 9th (enlarged) meeting of the leading group conducting feasibility studies on the Three Gorges Project. They made feasibility studies and held discussions about two special reports on the overall plan and water level of the Three Gorges Project and on a comprehensive economic assessment. Up to now, feasibility studies on about 14 special topics on the Three Gorges Project have been completed.

The Chang Jiang Three Gorges Project is the focus of world attention. In June 1986, the party Central Committee and the State Council released documents with the decision that the then Ministry of Water Resources and Electric Power organize experts in various fields to make further feasibility studies on the Three Gorges Project. In the past 2 years or more, 12 special groups made up of more than 410 experts and professors had successively held nine (enlarged) meetings of the leading group conducting feasibility studies on the Three Gorges Project, after on-the-spot surveys, an analysis of data and strict feasibility studies. They conducted feasibility studies on 14 special topics about the Three Gorges Project, such as geology, seismology, hydrology, silt, ecological environment, key structures, mechanical and electrical equipment, construction work, investment estimates, migration, flood control, power generation, shipping, a comprehensive assessment of the water level, and an overall economic assessment. It was learned that some experts had different opinions on such topics as electric power production, shipping, ecological environment, a comprehensive economic assessment, and so forth. They did not sign the relevant feasibility studies reports.

The chosen site of the Three Gorges Project is Sandouping, Yichang County, Hubei. It is designed with an annual generating capacity of 84 billion kilowatt-hours. Such comprehensive side benefits as flood control, shipping, and so forth are projected. Most of the experts involved in feasibility studies believe that the building of the Three Gorges Project is technically feasible and economically justified.

A responsible person of the leading group conducting feasibility studies on the Three Gorges Project told this reporter: A final decision on whether the Three Gorges Project is to be launched or not and whether it should be started at an early or not-so-early date will be made only after the completion of all feasibility studies. A feasibility studies report will then again be submitted to the Three Gorges Project Examination Committee under the State Council for examination and finally to the National People's Congress for consideration. It was learned that new feasibility studies reports on 14 special topics will be completed in the first quarter of next year.

Three Gorges Project News Briefing Held in Hubei

40130025 Wuhan Hubei Provincial Service in Mandarin 1000 GMT 13 Dec 88

[Text] The Chang Jiang Valley Planning Office held a news briefing yesterday morning to inform the press units in Wuhan of the situation in demonstrating the Three Gorges Project. Six experts, including (Wang Jiazhu), chief engineer of the Chang Jiang Valley Planning Office, answered questions put by reporters at the news briefing.

(Wang Jiazhu) said: The Chang Jiang Three Gorges Project is a large project which has attracted worldwide attention. Many experts and scholars at home and abroad have carried out demonstrations on this for over half a century. By the end of last month, when the ninth enlarged meeting of the Three Gorges Project Demonstration Leadership Group concluded in Beijing, and through 412 experts' and professors' hard work over 2 years and 5 months, the work of demonstrating 14 special subjects, comprising geology and seismology, hydrology, silting, ecology, key buildings, mechanical

and electrical equipment, construction, estimated investment, forestry, flood control, electricity generation, shipping, comprehensive planning and water level, and comprehensive economic appraisal, had been completed. A report on the demonstration had been adopted.

The general appraisal of the feasibility of the Three Gorges Project is that the economic results of the project would be good, the economic evaluation index is good, it is better to build it than not to build it, and it is more advantageous to build it at an early date than at a later date.

In the course of the demonstration, Sandouping of Yichang County of our province, about 40 km from Gezhouba, has been selected as the site of the dam of the Three Gorges key water conservancy project. The height of the top of the dam is 185 meters, the normal water level is 175 meters, the installed capacity is 17.68 million kilowatts, the annual electricity output is 84 billion kilowatt-hours and 40 million tons of coal used for thermoelectricity generation can be saved a year. Total investment in the project is some 36 billion yuan.

At present, the Chang Jiang Valley Planning Office is organizing forces to again draw up a new report on the feasibility of the Three Gorges Project on the basis of the results of the demonstrations by the 14 groups of experts. It is planned that the report will be submitted to the 10th enlarged meeting of the Three Gorges Project Demonstration Leadership Group for examination and discussion in the first quarter of next year. Whether the Three Gorges Project will be built or not and whether it is built at an early date or at a later date awaits a final decision by the CPC Central Committee, the State Council, and the NPC.

Ecological, Resource Impact of Three Gorges Project Analyzed

40081008 Shenyang SHENGTAI XUEBAO [ACTA ECOLOGICA SINICA] in Chinese Vol 8, No 3, Dec 88 pp 283-288

[Article by Hou Xueyu [0186 1331 3558], Institute of Botany, Chinese Academy of Sciences: "Effect of the Three Gorges Project on Ecological Environment and Resources"]

[Excerpts] Abstract: When evaluating the effect of the Three Gorges Project on the ecological environment and resources[1,2], the reservoir area and the upper, middle and lower sections of the Chang Jiang must be treated as an interconnected ecosystem. Building of the dam will inundate large areas of fertile soil, natural and cultural scenery of tourist value, many factories and certain mineral resources; it may also cause landslides, collapses and earthquakes. Serious soil erosion in the upper Chang Jiang valley may shorten the dam's lifetime, hinder navigation and lead to floods. The stocks of certain fish that inhabit running water will decrease. The dam's ability to control flooding in the middle and lower sections of the river has definite limitations, and it may hinder the ability of certain rare and valuable aquatic animals and fish that live in the middle and lower sections of the river to travel upstream for spawning. In addition, certain species of fish that inhabit the estuary will be affected and may not survive. The soil of the river banks will be bounded by sea waves and salinized. The amounts of soil materials carried to the estuary by the water will decrease. Whether or not to undertake the Three Gorges project should be carefully considered with reference to the above ecological effects.

I. Introduction

In the last few decades, both in China and abroad, policy making on water conservancy projects has largely considered reservoir projects in isolation and water conservancy in isolation. Consideration was usually given only to certain benefits that the country would gain from a given dam, while little thought was given to unpredictable water damage or disasters that it might cause, to say nothing of the effect that the project might have on the ecological environment and resources of reservoir area itself and the entire river valley. In recent years, only the water level in the three gorges has been evaluated, without first considering whether the project should be undertaken. As we know, within 20 years of its construction, 40 percent of the Sanmen Gorge Reservoir became silted, and owing to the lack of an advance ecological environmental evaluation, the silting not only caused several ups and downs in the project, with the need to demolish what had already been built, then rebuild it, but in addition it once threatened industrial and agricultural production and safety in the Guanzhong Plain and in Xi'an City. [passage omitted]

In China, evaluation of the Three Gorges project in the last several decades was also limited to the technology for constructing the reservoir itself, with no consideration of the effect that the project would have on the ecological environment and resources. Even though some people are now covertly urging that scientists who advocate maintaining the environmental balance are "naturists" like the Green Party[1], since the Third Central Committee session, and particularly in the mid-1980's, the enlightened Party Central Committee leadership has been extremely cautious about whether the Three Gorges project should be undertaken and in particular has instructed that importance should be attached to its effects on the ecological environment and on resources.

In evaluating the Three Gorges project, it has been quite necessary and normal to assimilate foreign experience and seek the help of foreign specialists in technical matters. But in evaluating the effect of the project on the ecological environment and resources we should not adopt foreign experience. For example, the Aswan Dam in Egypt is located in an arid zone of the tropics; it is a lake-type "potbelly" dam with a runoff of only 7.2 billion cubic meters but a reservoir capacity of 162

billion cubic meters. Because it is in an arid zone, it has a certain effect on the local climate. The inundated area was sparsely populated irrigated farmland in a gorge area. There was no industry in the area, and in particular the zone outside the inundated area had no inhabitants. The main purpose for building the dam was to solve irrigation problems in the arid zone, with the additional benefit of electric power production. There were no navigation problems, and, even more importantly, there was no possibility of ecological or resources changes such as those that would occur on the upper, middle and lower Chang Jiang. Nonetheless, the advantages and disadvantages of the Aswan Dam are still disputed, and after it was constructed a series of side effects resulted. For example, it caused salinization of soils in the Nile delta and a decline in soil fertility. It made the coastline recede at the river mouth, and in the lower section of the river outbreaks of schistosomiasis and malaria, a decline in water quality and nutrient levels and hydrologic changes greatly decreased the stocks of sardines in the estuary. The entire zone of the Three Gorges project is in a moist subtropical zone, so that it will have no effect on local climate, and it is a river-gorge dam with a runoff of 450 billion cubic meters and a reservoir capacity of only 10-20 billion cubic meters. The objectives of the project are flood control, power production, and navigation, all of equal importance, and the area that will be inundated is fertile soil along the banks that requires no irrigation, and densely populated industrially developed urban areas. The inundated area will total 700,000-800,000 square kilometers, generally with a population density of 20,000-30,000 or 35,000-40,000 persons per square kilometer. The Three Gorges themselves are a world-famous scenic area, with 5,000 years of historic and cultural resources; valuable aquatic animals unique in the world that are native to the entire river valley and estuary will be in danger of extinction, the output of certain economically valuable fish species of national importance will be affected; in addition, the pressure of population on the environment and the like far exceed those in the case of the Aswan Dam.

If we invite foreign specialists to discuss the effect of the Three Gorges dam on the ecological environment and resources, will they necessarily be wiser than Chinese scientists? Possibly, but not necessarily. First, foreign specialists are not as familiar with China's environmental characteristics and resource situation as many natural and economic geographers and environmental scientists. Even if we invite the foreign specialists to come and investigate the situation, they would not be able to put in as much time at it as Chinese scientists, who have visited many localities and have abundant data. The natural and ecological environments of foreign reservoirs are different, and the experience with them is only partially applicable to the Three Gorges. In addition, most foreign experts belong to engineering organizations, and they approach the task in terms of a single engineering factor; it is hard to imagine that they would correctly evaluate these complex effects that the project would have on the ecological environment and resources. Furthermore, some foreign experts might act in terms of the interests of their behind-the-scenes economic groups; during the project we would need to buy materials and equipment or borrow money from them, so that they would be likely to be affected by the interests of their cooperating groups, and some of them would unavoidably give subjective evaluations.

In evaluating the effect of the Three Gorges project on the ecological environment and natural resources, on the one hand the effects on tourist resources, the surrounding mountain regions, industry, mining, agriculture, fisheries and population relocation that would result from the construction of the dam and inundation of the land must be treated as an interconnected ecological system. In addition, we should treat the upper, middle and lower reaches of the Chang Jiang as a complete large-scale system and consider how the external environment would affect the lifetime of the Three Gorges project and the aquatic animal resources of the reservoir zone and the entire valley, as well as the changes in the estuary and the series of problems that would result. Examples include the effect that soil erosion resulting from prolonged cutting of forests on the upper Chang Jiang, retention of the abundant silt of the three rivers, a decrease in water quality and nutrient levels would produce on the life of valuable fish and economic fish in the middle and lower sections of the river, and the consequences of a decrease in sources of silt in the estuary for urban construction in the estuary and the like. Since these effects might occur in a short period, while some might appear only after a long period; some of them can be calculated in economic terms, while others cannot be evaluated in money terms and are hard to estimate. As a result, evaluating the ecological and resources effects of the project from the large unified system approach is a complex, profound, far-reaching, long-term problem of strategic significance. Addressing the 13th CPC Central Committee, General Secretary Zhao noted specially that: "While proceeding with economic construction, we must energetically protect and rationally utilize natural resources..., strengthen protection of the ecological environment, and better integrate economic benefits, social benefits and environmental benefits." This should be our guiding idea when we discuss the Three Gorges project.

II. Effect of the Project on Ecology and Resources in the Inundated Area and Reservoir Area

A. Irretrievable Inundation of Soil Resources

The area that will be inundated by the Three Gorges project includes 19 counties, 96 percent of whose area is hills and mountains, while 4 percent is plains. Although the arable land to be inundated totals 420,000 mu, it is the richest Quaternary alluvial soil in the provinces of the river-bank plain and contains neutral and microcalcareous purple soil of the hill areas rich in potassium and phosphorus, formed on Jurassic sandstone and shale. The arable lands in these areas that will be inundated

contain 73,900 mu of citrus orchards, while the other lands are planted to mustard root for pickling, a specialty product of Sichuan, and to Chinese pharmaceutical plants; the grain lands have a yield of 852 jin/ha. After these lands are inundated, all that will remain will be hilltops 300-500 m above sea level and mountain areas 500-800 m above sea level, which account for respectively 9.2 and 23.0 percent of the total area, while land at heights of 800 m or less accounts for 54 percent [as published]. The inclination of these hill and mountain areas exceeds 25 degrees; and some of them are cultivated slope areas and some are uncultivated. The area to be inundated has a population of 700,000-800,000 people, and the relocation of cities to mountain slopes and will suffer from a lack of arable land, and reconstruction of dwellings and factories will be rather difficult.

B. Irretrievable Loss of Natural Scenic Resources and Cultural Resources

The Three Gorges of the Chang Jiang are world famous. They are in an area of deep valleys, mountain ranges, swirling torrents, wave-lashed cliffs, an area of glorious scenery, in addition to which there are the three small gorges, with their splendid peaks and precipices, gushing springs, karst and pumice rocks, ancient roads among the overhanging rocks, creating a unique and multifarious atmosphere. This natural scenery, unique in the world, has attracted the common people. The Three Gorges and their surrounding area are a cultural treasurehouse with 5,000 years of history, including the famous Daqi cultural remains, and dozens of burial mount sites dating from the Warring States period through the Eastern Han to the Ming and Qing dynasties. Most of these cultural remains occur at elevations of 180-150-70 m above sea level or less. Once these scenic and cultural resources were inundated they would be irrecoverable. In the development of the socialist economy, the economic loss that would be sustained by China's tourist would be inestimable. Although some people believe that some of the landscapes and ancient structures can be moved, the original scenes would be lost and their value and significance would be greatly decreased. For example, the "stone fish" of Fuling (underwater rock carvings and fields of stone hydrologic tablets) could be reconstructed, but they would lose their significance as historic hydrologic records. The complete geologic profile, of the world's series of geologic profiles, would be inundated.

C. Immense Industrial and Mining Losses

The construction of the project would have a chain of undesirable consequences. The 180-meter plan would inundate 624 plants, including 6 major plants in Chongqing City. Here, the plants and factories location have formed a complex production system with a complete, close system of cooperation between them. While the enterprises whose plants will be inundated are being rebuilt elsewhere, when relocated enterprises recover and resume operations, if one of the enterprises with which they have ties has not been able to complete its construction, those that have already begun operations will not be able to function fully. As a result, the inundation by the reservoir will have a chain-reaction effect on the entire social ecology of the reservoir zone. In addition, the plant relocation will take up large amounts of land, there will be innumerable difficulties in reconstructing the plants in the remaining slope and mountain areas, and the earth-moving and excavation work in the mountain areas will unavoidably cause collapses, landslides, mudslides, erosion and the like. The reservoir will also inundate small copper mines, small coal mines and small gold mines, as well as limestone quarries used in cement production, so that the lost mineral resource potential is also inestimable.

D. Effect of Landslides and Collapses on the Reservoir

There have been a total of 214 landslides and collapses on the banks of the reservoir area, including 47 collapses and 167 landslides; the major landslides are mostly located in the region from Wan County to Zigui County, the heart of the reservoir area. The Xintan landslide in Zigui County that took place in June 1985 carried a total of 2 million cubic meters of material into the river, taking up an area over 100 m wide and kicking up waves 36 meters high, so that a storehouse on the opposite bank was engulfed by the river, 77 motor vessels were damaged, and nearly 10 people were killed. When the dam is built and the reservoir filled, softening caused by soaking and buoyancy will weaken the banks, so that old landslide will be activated, an ... particular, when downpours occur in the surrounding mountains, with no vegetation to protect the ground, landslides and collapses will become even more likely; if an earthquake induced by the presence of the dam should occur, large-scale slips and landslides will constitute a latent threat to the main dam and might block the Chang Jiang, hindering passage through the navigation channel. If the navigation channel is blocked, the errors that we make in this generation will be hard to rectify.

E. Inhibition of the Reproduction of Four Major Fish Species in the Reservoir Area

The Chenglingji section of the middle Chang Jiang from Chongqing to Lake Dongting is the spawning area of four major species of fish, the black carp, grass carp, silver carp and bighead, and part of it is in the section to be included in the reservoir. When the Three Gorges project is completed, as a result of water regulation and storage, the extent of the rise in water levels in the river below the dam will be perceptibly altered; peak water levels will be leveled off, and the degree of rise will be decreased, so that the flood conditions that the fish need will not occur and their reproduction will be inhibited. Warm-water conditions of 18°C or more needed for reproduction, but warming of the water will be retarded by the fall in temperature of the water released from the reservoir. Under the 180-meter plan, the drop in water temperature will postpone the reproductive period of the fish by

about 20 days. In addition, after the dam is constructed, erosion will cause many changes in the form of the riverbed, so that the sources of fish fry will be decreased, thus lowering the total productivity of the four species of fish.

F. Possibility of Earthquakes Induced by the Reservoir

Historically, 21 moderate earthquakes measuring 4.75 or higher have occurred in the reservoir area; the strongest earthquake measured 6.5. After the Three Gorges are filled with water, there will be a possibility of induced earthquakes. First, at elevations below 180 m in the reservoir there are large areas of limestone strata, where karst sinks of various size have developed, and after the reservoir is filled, the subsurface water and reservoir water may infiltrate into deeper layers along joints, where they will be separated by the impermeable sandstone on both sides, so that the water body will have highly favorable infiltration conditions, thus increasing the hydraulic pressure in the joints, and causing a decrease in the pressure resistance of the rocks. Second, in terms of the structural conditions, there still exist active fault systems or systems that have been continuously active since the Quaternary period. These are clearly visible on satellite photographs, indicating that the structural conditions favoring induced earthquakes exist in the reservoir zone.

G. Implications of Development Relocation of Population in the Reservoir Area

"Development relocation" refers to the development of industry and agriculture along the shores of the river in the reservoir zone. This approach, replacing the earlier method of simply paying the moving expenses of persons relocated for reservoir construction, is feasible, but the new plants and cultivation of mountain slopes will have a series of undesirable consequences:

1. Industrial pollution. Because the reservoir's environmental capacity for organic pollutants will be decreased, the urban pollution zone along the river will worsen and non-biodegradable organic pollutants containing mercury and other elements and man-made radionuclides will settle to the bottom of the reservoir, where they will pose a considerable latent ecological danger. In addition, construction of the reservoir will inundate coal and phosphorus mines, with the result that harmful substances will reach the reservoir bottom and accumulate in the bottom sediments. These pollutants may pass through the food chain to humans. When plants are built in the mountains, wastewater treatment and disposal will be more difficult than in the plains. Because there will be numerous winding roads, vehicles traveling them will often have to brake or change speed, so that noise pollution and exhaust emissions will greatly exceed those before the reservoir is constructed. The environment of the Three Gorges zone is closed, wind speeds are low, foggy days are frequent, the humidity is high, and the development of mines, chemical engineering, metallurgy and other smoke-producing industries will be extremely likely to produce atmospheric pollution, causing acid rain and other harmful phenomena, which may threaten the health of the inhabitants.

2. Soil erosion caused by agriculture. In the 1950's, the amount of forest cover in the counties along the river was generally 20 percent or more, while now it is only 5 percent. Owing to cutting of the forests, herbaceous vegetation now covers 30-40 percent of the area, so that the land ecosystem is extremely fragile. When the dam is built, the dense population along the shores will unavoidably expand to the mountain slopes, resulting in cutting of forests and reclamation of wasteland, and cultivation on the slopes will increase, with the result that soil erosion and impoverishment will become increasingly serious, and mudslides, landslides, droughts and waterlogging will become steadily more serious. If Dazhai-type terrace fields are built in the mountains, they will be vulnerable to erosion by downpours, creating difficulties for economic development and causing increased production expenses. As a result, investment per unit output will increase continually and agricultural output will be very limited, with the possibility of a vicious cycle in which increased reclamation leads to impoverishment of the soil, again leading to increased reclamation, thus unavoidably increasing the pressure on the environment.

H. Difficulty in Finding a Remedy for Inundated Citrus Orchards

The coastal plain in the area of the Three Gorges that will be inundated has thick soil that includes potassium- and phosphorus-containing purple hill soil. The moist climate, with an average annual temperature of 18-19°C, and the screening effect of the mountains, which block the cold waves of winter and spring, makes them suitable for growing numerous varieties of citrus. When the reservoir project is completed, 73,900 mu of citrus orchards will be inundated, accounting for 17.5 percent of the total inundated area, and the remainder will be areas of thin slope soil and bare rock. If Dazhai-type terraces are built on the slopes, not only will there be a shortage of sources of soil material, but if downpours occur after construction is completed, there is a danger that the terraces might be completely washed away. In addition, although the temperature of the reservoir may be raised by 0.4°C above that before construction, the air temperature falls with increasing elevation, and if the dam is 180 m tall, the increase in air temperature produced by the reservoir will be canceled by the effect of elevation. The main citrus-growing area is in the eastern part of the reservoir zone. The annual absolute minimum temperature in Xingshan, in eastern Zigui County, 275 m above sea level, has recorded minimum temperatures of -9.3°C, which can cause frost damage or frost kills of citrus trees. If the citrus plantations are extended to areas 600 m above sea level, the danger of frost kills will be increased. Some people have suggested large-scale development of citrus growing in the areas of

the reservoir zone with elevations below 600 m, using citrus growing to invigorate the economy of the inundated area; but this suggestion is dubious. Ecologically, the mountain slopes lack the combination of suitable temperatures and soil that would be needed for citrus growing.

III. Interaction Between the Project and the Ecological and Resource Conditions in the Upper Section of the River

A. Effect of Soil Erosion in the Upper Section of the River on the Lifetime of the Reservoir

The upper reaches of the Chang Jiang used to be China's second-greatest forest zone, and a major screen protecting the Chang Jiang's water resources. But since liberation, and especially since the slogan of "Taking grain as the key link" was introduced during the Great Leap Forward, the Sichuan Basin and surrounding mountain areas and the banks of the Wujiang River have experienced serious soil erosion as a result of cutting of forests and reclamation of wastelands. Slogans during the Cultural Revolution also called for relocation of some of the inhabitants of the basin to the mountain areas of Sichuan to build new villages and develop the mountain slopes. As a result, the forest cover of the southwest decreased from 28 percent in the 1950's to 13 percent in the 1980's, and the Sichuan Basin now has only 4 percent forest cover (as low as 1 percent in some areas). Soil erosion is extremely serious in the entire section of the river above the Three Gorges project, and silting of the reservoir will inevitably become increasingly serious. The amount of sediment entering the gorges every year was 510 million tons in the 1970's, while in the early 1980's it reached 680 million tons. Accordingly, silting has already become a major problem. Every reservoir has a lifetime. After the construction of the Three Gorges project, with a reservoir capacity of only 1-2 billion cubic meters, silting of the reservoir resulting from upstream soil erosion not only will cause a continuing decline from the objectives called for in the original plan, but even more seriously, it will threaten the lifetime of the reservoir, and the question of how many years will elapse before it must be abandoned is a matter of concern.

B. Effect of the Dam on Navigation in the Upper Section of the River

Chongqing and Wan County are major transport arteries between Sichuan and the southwestern provinces. If the main channel of the Chang Jiang is cut off by building a large dam across the river, although it will be possible to construct four or five locks, they will constrain each other and there will be many factors that favor malfunctions; throughput capacity will be small and the assured passage rate will be low. In addition, since river-bottom oolites and sand and eroded soil from upriver will be intercepted and will settle in the final section of the reservoir, even if water release for sand removal is practiced, it will be very difficult to remove the sediment from Fuling, Changshou, and Chongqing, so that these sediment buildups will gradually propagate upriver. When they pass through Hechuan and Huzhou they will also extend up the tributaries, building up the river bottom, and unavoidably affecting navigation in the upper reaches of the river. As a result, navigation along the tributaries to Chongqing and from there to Changshou not only will not be improved, but may actually be degraded. If Chongqing becomes a "dead port," the economic development of the southwest will be seriously affected.

C. Possible Flooding in the Upper Section of the River

The drainage area above the Three Gorges is extremely extensive, and if very large-scale flooding occurs, water drainage will become difficult, and the water backed up behind the main dam may enter the basin, inundating the Chongqing, Hechuan, and Jiangjin regions with their dense concentrations of population, agriculture, buildings and factories and transferring the flooding in the lower sections of the river to its upper sections.

IV. Effect of the Project on the Ecology and Resources of the Middle and Lower Reaches of the River

A. Effect on Flood Prevention and Waterlogging Prevention in the Middle and Lower Sections of the River

Although the Three Gorges project will perform the function of blocking river floodwaters, to some extent blocking the flood stage in the middle and lower reaches of the river, particularly in the Jin Jiang flooding area and at Wuhan, this effect will be limited. In some years Sichuan has very serious flooding while the middle and lower reaches of the river experience no flooding or waterlogging, but in some other years the middle and lower reaches of the river have serious flooding and waterlogging while none occurs in Sichuan upstream of the project. For example, in 1931 and 1954, the high-water levels were not great in the upstream areas of Sichuan, while in the Wuhan area of the middle and lower reaches the flooding was very serious. This is the result of downpours and the resultant floodwaters on such large tributaries as the Xiang, Zi, Yuan and Li rivers in Hunan and the Han River in Hubei. Conversely, in 1981, Sichuan had serious flooding, while no flooding occurred at Shashi and Wuhan in the middle section of the river. Because the Three Gorges could control only upstream floodwaters, while numerous measures would have to be taken to prevent flooding by the tributaries of the middle and lower Chang Jiang; in particular, the factors producing flooding of the Jingjiang area and Wuhan also result from the embanking of the lakes to reclaim land since the 1950's, resulting in a breakdown of natural reservoirs. In the early 1950's Hubei had 12.5 million mu of lakes, while now only 24 percent remains; thus in regulating flooding in the middle and lower sections, there is a necessity for planned reconversion of reclaimed land to lakes and conversion of some of the existing low-lying fields into flood-diversion regions, and in addition the raising and

strengthening of the Jin Jiang embankment must not be neglected. In particular, major importance must be attached to maintaining the vegetative cover and forests in the mountain regions of the upper, middle and lower sections of the Chang Jiang, and while building engineering reservoirs in various locations, sufficient attention must be paid to the protection and establishment of water resource-producing forests. In addition, we must by no means rely exclusively on the construction of the 1-2 billion cubic meter Three Gorges dam to completely solve flooding in the lower and middle reaches of the river.

B. Effect on Survival of Valuable Aquatic Animals and Fish in the Lower and Middle Sections

The baijitun [puffer], Chinese paddlefish, "rouge fish" and Chinese sturgeon in the Chang Jiang are precious and rare animal species. They are currently in a threatened state and are therefore in China's first category of protected animals. When Gezhouba was built, there were cases of kills of Chinese sturgeon below the dam. The spawning grounds of the aquatic animals mentioned above are all in the upper reaches of the river. In particular, after the dam is built, the Chinese paddlefish and rouge fish will not be able to swim to the upper reaches of the river to spawn, and the fry and juvenile fish will not be able to swim to the lower reaches to continue the life cycle. The habitat of the baijitun in the main channel of the middle and lower Chang Jiang is primarily a winding section of the river; after the Three Gorges project is completed the watercourse in the central section of the river will tend to straighten, so that its ecological environment will be lost. After the Chinese sturgeon swims upstream to the middle and lower reaches of the Chang Jiang, it must pause in a quiet environment without catching food in order for its sex glands to mature. The middle Chang Jiang is the area where the parent fish congregate, and after the Three Gorges project is completed and navigation increases, the Chinese sturgeon are likely to be killed by the propellers, and the increased noise and interference will affect their normal sexual maturation, with the result that the stocks will naturally decline.

C. Effect on Production of Economically Valuable Fish in the Estuary and Adjoining Sea Area

The Chang Jiang continuously carries nutrient-rich fresh water. The environment is complex in the estuarine area where the fresh water and sea water mix, and as a result, numerous ecological categories of animals congregate in the estuary area for spawning, development, and feeding. When the dam is built, the rich sediments will settle in large quantities in the reservoir. In addition, as a result of changes in the times at which low water and high water occur and changes in the water quality and hydrology of the estuary, such brackish-water animal forms that originally lived and spawned for long periods in the estuary as the fengweiyu, whitebait, mullet and white shrimp may decrease in numbers or disappear. The valuable Chinese sturgeon, which fattens in the estuary and then swims upstream to the upper and middle Chang Jiang to spawn, will be blocked by the dam. The hilse herring, which swims upstream from the estuary to quiet lake areas to spawn and then swims downstream to the estuary to fatten, will decrease in numbers as a result of the change in water quality and nutrient levels. River crabs, which spawn in the estuary and then swim to the lower Chang Jiang to fatten, may also become less abundant as a result of a shortage of food in the water of the river. In addition, the vital activity of the white eel and China crab, which spawn in harbors and return to the sea to develop, will be adversely affected. The Choushang bank, near the Chang Jiang estuary, is formed by confluence of the fresh water of the Chang Jiang and the warm Taiwan Current. In spring the Taiwan Current increases in strength, the water temperature rises, and food organisms become abundant, the hairtail, greater and lesser yellow croaker, and prism crab and others migrate to the offshore area and estuary to spawn and forage; in the winter they again move to deep-sea waters to overwinter. The construction of the dam will cause changes in the estuarine hydrology and in water quality and nutrients, so that the Zhoushan bank's position and fishery production are likely to be altered.

D. Effect of Entry of Salt Water Into the Estuary on Industry and Agriculture

The low-water period in the Chang Jiang estuary is now from November to April, when salt water infiltrates the two shores, which already causes serious damage to industrial and agricultural production and drinking water. It affects such industries as textiles, foodstuffs, pharmaceuticals, metallurgy, chemical engineering and electronics. The Baogang, Yangshupu, and Shidongkou power plants have already invested 110 million yuan in desalination equipment to assure the availability of boiler water. In addition, Baogang has built a salinization-proof fresh water storage pond on the shores of the river at a total investment of 120 million yuan. Infiltration of salt water also has a major effect on human health. After the Three Gorges dam is built, filling of the reservoir in October will cause changes in the duration and intensity of infiltration of salt water in the estuary, which, combined with northward diversion of water and water use by Jiangsu and Anhui provinces, will cause serious soil salinization in the estuary zone and the foredelta. After the dam is built, the amount of water released will increase in January-April, causing a rise in the subsurface water level. This may prevent free mixing of river water and subsurface water, so that waterlogging and salinization will be intensified. The situation will be unfavorable for cotton and wheat production along the river. In addition, during the time when the reservoir is full, there is a potential danger that salt water will penetrate into the Taihu Lake water system.

E. Effects on Shoreline Accumulation and Erosion in the Estuary and Delta

The Chang Jiang estuary is the primary destination of riverine sediments. When the suspended sand carried in

the fresh waters reaches the estuary, sea water coagulates it, so that large amounts of fine materials are precipitated, continually increasing the estuarine land area. Four hundred years ago, Shanghai's eastern shore was located at present-day Qingongtang, and for the last thousand years, Shanghai's coastline has been advancing at a rate of 70 meters a year. The land in northern Jiangsu, on the left bank, has been advancing even more rapidly, and in the last 70 years the newly formed Qidong, Rudong, Dafeng, and Sheyang counties, with a total of more than 90 million mu of agricultural land, have been enriched by material brought by the river from Sichuan. After the Three Gorges project is built, most of the sediment will be precipitated on the bottom of the reservoir or in the headwaters, so that not only will the estuarine land resources not be added to as rapidly as before, but shore erosion may even occur, with a possible retreat of the shoreline. In particular, the northern section of the south-facing Hangzhou Bay will experience a decrease in the supply of sediments, which may increase the intensity of erosion of its northern shore and of certain coastline sections. In addition, sediment accumulation will slow in the eastern shallows of Chongming Island, and the sources of sediment will decrease, which will increase the sediment undersaturation along the eroded sections of coastline, expanding them and increasing the endangered land area.

F. Effects on Navigation in the Estuary and Lower Section of the River

A survey made by the author in Nantong in 1985 indicated that if sea water flows upriver after the Three Gorges dam is built, the north branch of the Chang Jiang between Chongming Island and Nantong will be subjected to tidal influences, which may cause silting, thus blocking navigation. In addition, Zhangjia port in Shazhou City, Jiangsu, is a newly established port in the heart of the Chang Jiang estuary where the current water level accommodates mooring of 10,000-ton steamers. After the Three Gorges project is built, each year while the reservoir is full, the water level of the port may drop, affecting navigation there. Four kilometers upriver of Zhangjiakou is the planned site of the country's largest nuclear power plant, which uses sea water for cooling and discharges it into the river. Although the discharge water is treated, it unavoidably contains a certain amount of radioactive materials, which under ordinary conditions will be diluted by the river flow so that it produces no harm. But during the period each year when the reservoir is full, the river water will have a decreased ability to dilute the radioactive substances discharged into the river, which will unavoidably affect water quality at Zhangjia port 4 km downstream and thus may indirectly affect the development of navigation at the port.

To summarize, the Three Gorges project will have profound, far-reaching, serious effects on the ecological environment and resources, but there still has been insufficient research on the subject. Numerous scientific fields and government departments should be organized for in-depth investigation in order to obtain reliable scientific evaluations. Some ecological-environment changes and effects are difficult to evaluate over a short period, and many effects are latent, involving slow changes, whose benefits or disadvantages are hard to quantify, and whose degree, limits, range and time scales are unclear, so that prolonged monitoring and investigation are required. Some of the unfavorable effects described above are the author's personal opinions, which may not be correct, but are offered for discussion. But in ecological terms, the question of whether the Three Gorges project should be undertaken affects the strategic orientation of the national economy's development and the fate of future generations, and should therefore be carefully considered, and the policy decisions should not be made by a small number of departments or individuals.

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Light Gas Turbines Seeing Wider Use

40130028 Beijing GUOJI HANGKONG [INTERNATIONAL AVIATION] in Chinese No 8, Aug 88 pp 4-6

[Article by Wang Zuhu [3769 4371 3338]]

[Text] Abstract: Since the 1970's aero-derivative gas turbines have provided China with dependable marine and industrial power for such diverse applications as ships, electrical power generation, and natural gas and oil processing and pumping. Achievements in light gas turbine technology are presented below.

Light gas turbines are modified aviation gas turbines or developed on the technology base of aviation gas turbines. They are new power sources for industrial applications, ground vehicles, and ships. Since the 1960's foreign countries have made rapid progress and extensive use of gas turbines for ground vehicles and ships. China made a late start in the development of light gas turbines. In the development of a new technology, the manufacturing sector must go through a development and maturation process, the application departments must understand and adjust to the new technology, and the new technology must go through a promotional and popularization process in the society. The development of light gas turbines in China will have to overcome a multitude of difficulties in order to move forward.

I. Development and Achievements

In 1980 the Ministry of Aviation Industry designated light gas turbines as a priority development product targeted for technology transfer from military to civilian uses. This effort was actively promoted by the original State Machine Building Commission (later the State Economic Commission) and supported by the State Planning Commission, the State Science and Technology Commission, and the Commission of Science, Technology and Industry for National Defense. Development policies were made and organizational action taken to put China's light gas turbine industry into a new era. Production volume and machine variety have expanded, service and compatibility have improved, and the ranks of specialists and cooperative partners have grown. Economic and social benefits are now being seen. All in all, the new endeavor has made substantial progress.

The application of light gas turbines in land-based oil fields is still not very common in China. Since the technical targets and reliability requirements for offshore oil field applications are more stringent, the development of light gas turbines in China should be for land use first. Once sufficient success and experience have been acquired on land, the turbines can then be applied on offshore oil platforms. In terms of product development, Chinese-made aircraft turbines will be first modified according to the user's needs, then a series of products will be developed and after-sale service will be strengthened. The goal is to introduce the products as soon as possible to serve the national economy. Also, international cooperation will be pursued to develop high-performance gas turbines.

1. Product Variety and Quality Are Improving

More mature products today include WJ5G, WJ6G, WP6G, and WZ6G. Since the 1970's, a total of 58 sets of 35 models of gas turbines have been provided to the users. The total capacity is 120,000 kilowatts and the units are distributed in 11 oil fields in 10 provinces and municipalities (see Figure 1). The total accumulated operating time has exceeded 310,000 hours.

2. Moving Toward Complete Lines of Products and Expanded Services

Initially, a single model of gas turbine was available to the customer and experience showed that to really develop gas turbines and to satisfy the customers' needs, a complete line of products should be developed. So far, seven different systems have been developed for electric power generation, heat and electricity generation, water

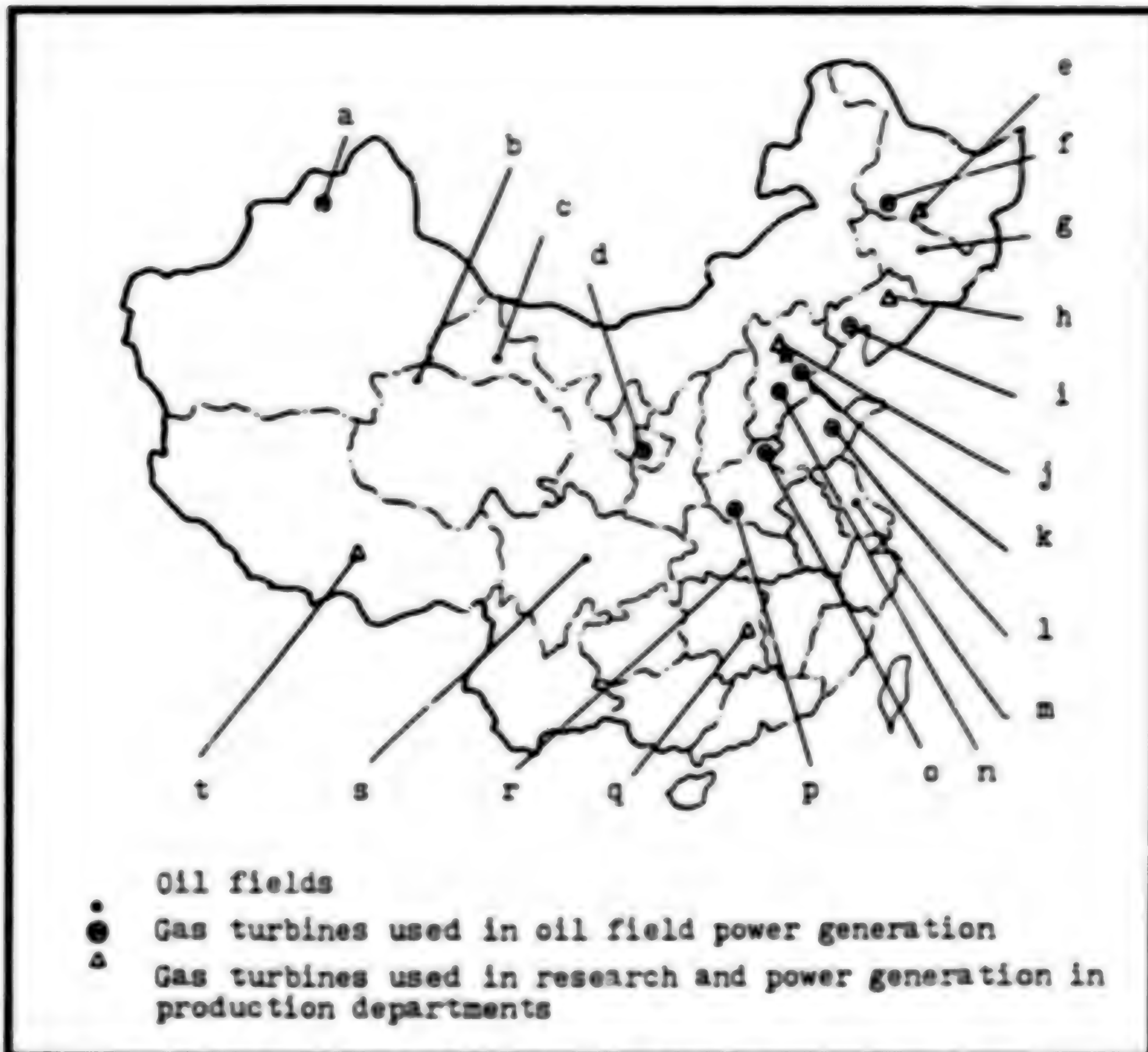

Figure 1. Distribution of industrial gas turbines modified from Chinese-made aircraft engines.

Key:
a. Karamay
b. Lenghu
c. Yumen
d. Chengqing
e. Dongan Company
f. Daqing
g. Fuyu
h. Liming Company
i. Liaohe
j. North China Heavy Machinery Plant
k. Dagang
l. Shengli
m. Jiangsu
n. Renqiu
o. Zhongyuanp.Nanyangq.Nanfang Company
r. Jianghan
s. Sichuan
t. Lhasa power plant

injection, water and heat supply, natural gas pressurization, hydrofoils, and coal mine fire-fighting. Users have included petroleum, chemical, shipping, railroad, and coal mining industries.

3. Making Products More Adaptable and Improve After-Sales Service

The early models of Chinese-made gas turbines were relatively poor in reliability, adaptability, and economic performance. To solve these problems, more complete systems had to be built, and the machine adaptability and after-sale services had to be strengthened. To improve quality, the main body of the machine was first modified. Aluminum blades were replaced with steel and titanium alloy blades, wear resistance and bearing lubrication were improved, the noise level was lowered, and corrosion protection was improved. The average time between overhauls of the gas turbines was raised to 4,000 hours and the single unit record operating time was 13,400 hours. In addition, three different control protection systems were developed and one of them has already been installed and operated for 6,000 hours.

Product reliability involves the reliability of the gas turbine and the accessories and the level of operation and maintenance. Proper operation and maintenance can make up for deficiencies in the equipment. In terms of after-sale services, the Liming Motor Company has done a superb job. They contracted operation service after sale, personnel training, and provided spare parts. Because of their good support and service, the average annual operation time of WP6 units has reached 7,500 hours, even though the WP6 is not an advanced machine. The first WP6 was put into service in October 1984 at the Daqing oil field and now there are 10 units operating there.

4. Developing International Cooperation

China made a late start on the development of gas turbines and still lags behind the international standard by a considerable distance. In order to develop this high-tech product, China must bring in foreign technology, promote international cooperation, develop advanced models, and improve its current models. International cooperation activities currently underway include purchase of foreign products for customers, importing advanced technology, joint development of advanced gas turbines, submitting joint bids with foreign companies, providing repair service, and conducting single task technical cooperation.

5. Developing Preparatory Research and Making Technical Preparations for Future Markets

Based on China's coal-based energy policy, actively research gas turbines powered by various fuels, especially coal. The Xi'an Motor Company has made considerable progress in the development of coal gas generators. Using research results of gas combustion chambers that burn medium heat content coal, the Wuxi No 2 Institute for Machine Building developed light gas turbines powered by a coal-water mixture in the chemical fertilizer plant at Xiaogan, Hubei. The crude-oil-powered model 200 gas turbine developed by the Nanfang Company is also being tested.

6. Establishing a Well-Organized Team of Specialists

The process of developing a new technology is also a process of training and cultivating a team of talents. As a new enterprise, we must not only have our own gas turbines, but also our own technical teams. Since the ground-use gas turbines are developed on the basis of aircraft turbines, the development of gas turbines in China has always been led by the Ministry of Aviation Industry. Now, the China Light Gas Turbine Development Center is responsible for the overall planning, development, manufacturing, system building and improvements.

The complete engineering effort of gas turbines requires a high-tech heavy industry, large investments and long development period. Such an effort cannot be handled by individual units; the whole profession must participate and work on different specialty tasks. To date, two gas turbine companies, Liming and Nanfang, have been formed and two production lines have been built. In addition, a modulation control system production line has also been established in the Xi'an Aviation Engine Parts Plant No 1. While establishing specialty units, lateral collaborations have also been pursued. In cooperation with the Chinese General Company of Ships, a ship and industry engine center was formed to develop power systems for ships. Jointly with the former Ministry of Ordnance Industry, engines for tanks have been developed. A joint effort by the Xi'an Engine Company and the Engineering Thermal Physics Institute of the Chinese Academy of Sciences led to the formation of the Zhonghua Gas Turbine Research and Development Company for the development of the Spey gas turbine. Last year two agreements were reached with the former Ministry of Petroleum Industry to develop oil field applications of gas turbines.

China has made a good start in the development of light gas turbines. In the modernization of the country there will be heavy demands on energy and transportation; since gas turbines can play an important role in these areas, there is a broad market need for them.

II. Future Tasks

It was pointed out by Deputy Minister Jiang Xiesheng [1203 3610 3932] of the Ministry of Aeronautics and Astronautics that the development of gas turbines is entering a new era and a major step is needed in 3 years in the area of system building.

Based on the development situation of gas turbines in China, the following tasks are urgent:

1. Improve the Reliability, Compatibility and Economic Performance of Current Gas Turbines

The most urgent task on hand today is to improve the reliability of the products so that the customers can use them confidently. The models in use today were modified and developed based on early models of aviation gas turbines; their efficiency and reliability are therefore less than satisfactory. However, they have the advantages of a lower price, not requiring foreign exchange, and good after-sale services. As long as they can operate reliably, there is still a short-term market in China for these models. We should concentrate our efforts on improving the reliability of current models in order to increase the overhaul period to 8,000 hours while improving the economic performance of current models. Since limited structural modifications can be made on current models, improvements of the economy will have to come from such practices as combined gas-steam cycle, heat and power co-generation, steam re-injection, and utilizing regenerators or intermediate cooling. The goal is to achieve a simple cycle efficiency of 25-30 percent and a thermal utilization rate in heat and electricity co-generation of more than 70 percent.

2. Developing Advanced Models of the 1980's

We must combine the development of the next generation of aircraft gas turbines with the development of advanced gas generators. An effort should be made to produce Spey gas turbines in China. With a thermal efficiency better than 30 percent, the Spey is an advanced model in the 10,000-kilowatt category. The development of the Spey in China should be accelerated. In the meantime we should cooperate with Rolls-Royce to produce the SK15HE to meet the urgent needs of customers. In addition, we should collaborate with Allison in the development of gas turbines that burn crude oil.

A concentrated effort should be made to cooperate with United Technologies of the United States in the development of the 1990 era FT-8 gas turbines to satisfy the market needs of high-capacity models. We should raise the technology level of aviation gas turbines and improve the compatibility of the models. For the next generation of passenger airplanes, we need to develop a modern 6,000-kilowatt engine. Through international cooperation, we must improve management standards and competitiveness. It is expected that light gas turbines in five power categories will become available: less than 1,000 kW, 2,000-4,000 kW, 6,000 kW, 10,000 kW, and 25,000 kW. While developing gas turbines, compatible components and compressors should also be developed to improve the ability for system building.

3. Strengthening System Building Ability and Organizing "Turn-Key" Engineering

System building is more complicated than single gas turbine engines and is the weak link in our ability. Turn-key engineering systems are needed by the market and the users. The ability to provide complete systems has a direct impact on the competitiveness of Chinese-made gas turbines; we therefore must succeed in this area.

4. Setting Priorities and Sharpening the Focus

Advanced gas turbines have wide applications but our R&D resources are limited. We must therefore concentrate our effort on selected priority tasks in order to achieve rapid results. Because China has a huge territory with widely scattered oil fields, the major customers for gas turbines should be the energy and transportation industries, especially the petroleum industry. Subsequently, the application of gas turbines should be extended to the petrochemical, chemical, shipbuilding, railroad, and coal industries. To solve the urban energy supply problem, gas turbines must be able to use coal as a fuel. IGCC and combined cycle of intermediate-combustion-value coal must be established as a high priority task. In the meantime, speed up the development of combustion chambers for low-combustion-value coal in order to prepare for the supply of gas, electricity and heat to the cities and make some contributions to the solution of energy and environmental problems.

5. Combining Urgent Near- and Long-Term Production Issues; Developing Applied Technology

The major issues here are the research for prolonging the service life of the gas turbines, the development of steam re-injection and regenerator technology, the study of power generation for desert and offshore oil fields, and the establishment of standards and codes and quality control of light gas turbines.

6. More International Cooperation; Facing the Foreign Market

More international interaction is needed to carry out the reform and open policy and to improve the technical and managerial standards of the gas turbine industry. Through international interaction, we can improve our product quality and personnel technical level, and participate in international trade. Specific tasks at hand are collaborative development, introduction of machine systems and entering the international market with single items and systems.

Guizhou Power Shortage Looms

40130038b Guiyang Guizhou Provincial Service in Mandarin 2300 GMT 11 Nov 88

[Text] Guizhou will be short of electric power this winter and next spring. In view of this, the provincial power supply office has issued a decision on planned power consumption. The decision says that it is necessary to immediately stop supplying power to enterprises that operate on a seasonal basis, and also stop taking on new customers. Power supplies for high energy-consuming enterprises such as small iron, carbide, and iron and steel plants must be greatly reduced. With the exception of a few enterprises whose power supplies are covered in separate plans, all enterprises must arrange their power consumption based on a 5 percent reduction of supply. Those that exceed the consumption plan must make up for the excess next day; if they cannot, they will have to suffer economic sanctions.

The provincial government is stepping up the construction of phase three of the (Xinzhai) power plant in an effort to place it in operation at an early date, so as to ease the province's power shortage.

Expansion Projects, Pumped-Storage Stations Suggested for East China

40130031 Beijing SHUILI FADIA [WATER POWER] in Chinese No 9, 12 Sep 88 pp 6-7

[Article by Zhang Fahua, director, Huadong Survey and Design Institute, MWREP]

[Excerpts] After the concerted struggle of the Ministry of Water Resources and Electric Power's Twelfth Engineering Bureau and the Huadong [East China] Survey and Design Institute, the six 50,000-kilowatt generating sets of the Jinshuitan hydropower station will all have commenced operation by late 1988. [passage omitted]

The Jinshuitan hydropower station was originally designed to include four 50,000-kilowatt generating units, for a total installed capacity of 200,000 kilowatts. Work was begun on this project during the last half of 1981. The river was dammed in October 1983. When excavation for the dam foundation had been completed and concrete was about to be poured, the state approved construction of the Shitang hydropower station below Jinshuitan. The construction of the Shitang hydropower station will result in a regulated reservoir. The flow rate of 50 cubic meters per second to sustain navigation called for in the original design of Jinshuitan will now be maintained by the Shitang reservoir. Therefore, the conditions exist for increasing the total installed capacity of the Jinshuitan hydropower station, making it a complete peak load-compensating power facility. After demonstrations and comparing plans, the final decision was to install, in the station behind the originally designed dam, two more 50,000-kilowatt generating units, increasing the installed generating capacity to 300,000 kilowatts.

The expansion of the Jinshuitan hydropower station was proposed under the following conditions: the preliminary design had already been approved, work plans were being urgently drawn up, foundation excavation for key construction had been basically completed, and concrete for the dam was about to be poured. Therefore, the change necessarily increased both the amount and the difficulty of the work for the design and construction units. For example, regarding design, after expansion there will be two more generating units in the plant behind the dam, the placement of the plant must be raised; the space between generating units was reduced from 14.5 meters to 13.5 meters; auxiliary plants are to be built on the reaches above and below the main plant; the arrangement of the penstocks for power generation was changed from four in two pairs to six individual pipes. Therefore, the original engineering drawings for the power house and penstocks were all useless. Faced with this, the designers thought that the per-kilowatt cost of expanding the installed generating capacity would be low, and the effect of smoothing out load peaks and valleys and ensuring safe, economical operation of the East China Power Grid would be great. Therefore, it was decided to put the national interest first. [passage omitted] To save money and ensure normal power station construction and manufacture of generating equipment, it was promptly proposed that three points not be effected, i.e., the time originally set for pouring the first batch of concrete, plans for bridging the flow and for annual construction, entry into operation of the first generating unit in 1986 and basic completion of work in 1988. It was also proposed that design principles in two areas not be changed, i.e., the arrangement of the dam and floodgates and the type of generating units to be used. These principles received strong support and accommodation from the Twelfth Engineering Bureau and the Hangzhou Electric Power Generation Equipment Factory, facilitating the smooth implementation of the generating unit expansion work at the Jinshuitan hydropower station.

After generating unit additions, the annual generating capacity of the Jinshuitan hydropower station is 490 million kilowatt-hours and annual utilization time 1,790 hours. It provides a compensatory capacity to the East China power system of 25,000 kilowatts and a frequency modulated, incidental reserve capacity of 50,000 kilowatts. The four generating units which were to have commenced operation last year and the one which has already come on-line this year (number six is currently being installed and tested preparatory to entering operation at the end of the year), together generate over 600 million kilowatt-hours. This provides the required capacity to moderate fluctuation problems and improve electric power grid safety in the East China power system. From the point of view of increased investment, the total cost for the two additional 50,000-kilowatt generators is only 24 million yuan, a per-kilowatt cost of only 240 yuan. This is much more economical than any other method of compensating for peak loads in the power system. From the practical experience of expanding the generating units at the Jinshuitan hydropower station we have learned the following: The trend of hydropower construction in the East China region should be expansion of the installed generating capacity of some existing power stations, simultaneous with construction of new conventional and pumped-storage hydroelectric power stations, thus increasing the hydropower utilization rate, this is an important method of solving the problems of the East China Power Grid.

Economically the three provinces and one municipality (Zhejiang, Jiangsu, Anhui, and Shanghai) of the East China Power Grid constitute one of the most highly developed regions of China. In this region there is a power shortage, electric power is in great demand. The fluctuations in power grid load are extreme. It is estimated that, in 1990, peak load will reach 19 million kilowatts, peak-to-valley fluctuation will be 5.32 million kilowatts. By 1995, the peak load will reach 29.6 million kilowatts. As this power grid is based on steam generation, the capacity to compensate for peak loads is seriously inadequate. At present, only 1.3 million kilowatts of hydropower capacity is used for load compensation.

The power grid is operating without reserve capacity and without peak load compensation methods. This causes low load with high cycles or high load with low cycles, often creating a power overload situation. In the statistics for 1985 alone, there are 3,710 instances of a level-one overload in the power grid. Under these circumstances, hydropower construction in the East China region should be accelerated, however, the hydropower resources in East China are limited, moreover, development was relatively early, the conditions for development of remaining exploitable resources are not ideal, especially as concerns the great difficulty of resettling people living in reservoir areas. This raises the cost of power stations. In these circumstances, to ease funding problems and to solve the load fluctuation and incidental reserve capacity problems, expansion can be carried out on existing hydropower stations and new pumped-storage stations can be built. This is a more economical and effective solution. We consider that Hunanzhen, Huangyunkou, and Xinanjiang, plants which have been in operation for many years, all have the conditions needed for expansion. Carrying out of the work should be accelerated. We also suggest the earliest possible renovation of the Tianhuangping pumped-storage power station. In the future, newly constructed mid- to large-sized power stations should, as conditions allow and to the fullest extent possible, reserve land needed for subsequent expansion.

Many countries place great emphasis on renovation of existing hydropower stations. The East China region does not have much hydropower potential. Those resources within the three provinces and one municipality of the power grid which could be developed, are, for the most part, already developed. The primary problem encountered in expanding installed generating capacity, and increasing the number of peak load compensating generators is electric power pricing policy. Rational expansions of existing power stations all yield economic returns to both the power grid and to society. However, limitations are imposed by the present system and the fact that a good selling policy based on high prices for power has not been put into effect. Also, the capacity for profit has not been calculated. This has caused great difficulty for power stations in paying back principal and interest on loans. Taking Jinshuitan as an example, although the expansion added a 100,000-kilowatt peak load compensation capacity, it only added 3 million kilowatt-hours of power annually. Although this represents an investment of 24 million yuan, the power station's liquidity and economic return have decreased. If this abnormal and irrational situation is not solved, then it will limit the development of hydropower and prevent full utilization of hydropower to compensate for peak loads and provide incidental power reserves. China is now implementing price reform and we hope the long-standing electric power pricing can be adjusted, thus promoting even greater development of the electric power industry. [passage omitted]

Gezhouba's Final Unit Operating

40100024a Beijing CEI Database in English 14 Dec 88

[Text] Wuhan (CEI)—The last generating set of the Gezhouba Hydropower Station, the largest of its kind in China, went into operation on December 10. Thus the construction of the 21-generating set hydropower station with an annual capacity of 2.715 million kilowatts has been completed.

Work Now in Full Swing on Lijiaxia Station

40130037 Beijing RENMIN RIBAO in Chinese 11 Nov 88 p 1

[Text] The Lijiaxia hydroelectric station is the second large-scale project on the Huang He following the Longyangxia hydropower station. Lijiaxia is second only to Gezhouba in terms of installed capacity and will be the cheapest in terms of investment per kilowatt in the entire country. The hydropower station is a major construction item in the Seventh 5-Year Plan. It is located on the border of the counties of Jainca and Hualong in Qinghai Province. Here, the river gorge is deep and precipitous—ideally suited to the construction of a dam. The installed capacity of the station will be 2 million kilowatts, making it the second largest in the nation. It will depend on the reservoir of Longyangxia 110 kilometers upstream for its regulated power generation so the loss from inundation will be minimal; its cost will be cheap—only 830 yuan per kilowatt, the lowest of any hydropower station in the country. Work on the station was begun officially in April 1988.

Big Pumped-Storage Station Planned for Hebei

40100018a Beijing CHINA DAILY in English 10 Nov 88 p 2

[By staff reporter Xu Yuanchao]

[Text] China plans to build a pumped-storage station in Hebei Province to help ease the power shortage in Beijing, Tianjin, and Tangshan.

Such a station works on the principle that the greater the drop in water level, the more power can be generated. Electricity is used to pump water from one level to a higher one, whence more electricity can be generated.

The 1,500-megawatt station, the largest of its kind in China, is expected to generate 2.8 billion kilowatt-hours of electricity, when completed by the year 2000, said Li Haojun, senior engineer of the China Water Conservancy and Hydroelectric Power Planning and Design Institute.

He told CHINA DAILY that the station will pump water from the lower reservoir to the upper one during low-load hours and generate electricity in peak-load hours.

Experts forecast that the daily electricity consumption in peak-load hours will reach 27,400 megawatts by the year 2000 and 16,150 megawatts in low-load hours.

"The Beijing-Tianjin-Tangshan electric power grid will be unable to supply enough power to bridge the gap," Li said.

Located in the natural reserves of Xinglong County in Hebei Province, the station will create an 880-metre change in water levels. The upper reservoir is designed to contain 2.9 million cubic metres of water, he said.

Investment in the project will total 1.34 billion yuan and construction of the station will take about 6 years.

Li said the Tianjin Hydropower Prospecting and Design Institute under the Ministry of Water Resources will finish the feasibility study by the end of next year. Experts will then meet to discuss a preliminary design.

Work Begins on Tianhuangping Pumped-Storage Hydropower Station

40130042 Shanghai JIEFANG RIBAO in Chinese 15 Oct 88 p 1

[Text] After more than 10 years of surveys and demonstrations, initial-stage work on the Tianhuangping power station—the first large pumped-storage hydropower station in the East China Grid—is now formally under way. The agreement on funding was signed in Hangzhou on 8 October.

The Tianhuangping pumped-storage hydropower station is located in Anji County, Zhejiang Province. Here the topography and geology are excellent, little civil construction will be necessary and little land will be flooded. The station could have six 30,000-kilowatt reversible generators installed for a capacity of 1.8 million kilowatts.

Following its completion, Tianhuangping will not only provide some 1.8 million kilowatts in regulatory capacity for the East China Grid, it can absorb 1.92 million kilowatts of electricity during the night power-use "valley." This will correct the former pattern of operating by day and shutting down at night of the 12 million kilowatts in thermal power equipment [illegible] at these facilities can increase their output and [illegible] a stable supply of electricity. When an accident occurs within the grid, Tianhuangping can supply emergency power to guarantee the safe operation of the grid.

Construction funding for the power station was pushed by the East China Grid Leadership Group and the Ministry of Energy Resources with the money being provided by the State Energy Investment Corporation, the East China Electricity Management Bureau, the related departments of the governments of Jiangsu, Zhejiang, and Anhui and Shanghai Municipality with participation at the national, local, and enterprise level.

Agreement To Import Equipment for Geheyan Station

40130039a Beijing RENMIN RIBAO in Chinese 12 Nov 88 p 2

[Text] The China Technology Import-Export Corporation and five Canadian firms signed an agreement on 11 November in Beijing to import the turbine generators and electrical and other equipment for the Geheyan hydroelectric power station in Hunan Province. This hydroelectric power equipment is being imported by China using a loan provided by the Canadian Government. The hydropower station is located in the Qing Jiang River Basin in Hubei Province and will have a total installed capacity of 1.2 million kilowatts.

Hainan Investing Heavily in Thermal Power

40100021a Hong Kong HONGKONG STANDARD in English 14 Nov 88 p 5

[Summary] Hainan Province, its power crisis temporarily solved by a massive investment in thermal power, may switch to nuclear power after the year 2000.

Hainan has been plagued by serious power shortages since late 1986 as a result of a 2-year drought which reduced water storage to less than 30 percent of its normal level, crippling hydroelectric operations.

Mr Wang Shoushen, general manager of the Hainan Province Electric Power Company, said the Hainan government would invest 4 billion yuan in developing thermal power for the island's use up to 1992.

"Last April, we conducted a feasibility study on nuclear power development on Hainan with the Ministry of Nuclear Industry in a move to fight the power shortage," Mr Wang said.

"As Hainan does not have coal reserves and the transport cost for coal would be too expensive, we must develop nuclear power in the long run.

"But it will be too early for us to build a nuclear plant now as the cost is too high. We will consider plans to develop nuclear power after 2000 when the estimated power consumption will exceed 3 million kilowatt-hours."

Thermal power was the most effective short-term solution, Mr Wang said.

He said the provincial authorities had ordered the company to quicken construction of the Haikou Power Plant at Macun to solve the serious power shortage.

Hainan has a generating capacity of 385,000 kilowatts, of which hydroelectric power contributes 252,000 kilowatts and thermal power 133,000 kilowatts.

The Haikou city administration has provided a rotating power supply since last February. Factories were forced to stop production because of frequent breakdowns of electricity supply.

"The first stage of power development will be planned to meet Hainan's demands up to 1990, which will double the existing generating capacity of 300,000 kilowatts," Mr Wang said.

Building of the Macun plant started in November last year and the first 50,000-kW generator is now serving Haikou city.

"Another generator with the same capacity will start production by the end of this year."

Two other generators, each with a capacity of 125,000 kilowatts, will also go into operation, one in July and the other in March 1990.

"The second stage of power development will increase the total capacity of 550,000 kilowatts in 1990 to 2 million kilowatts, which is expected to satisfy needs until 1992," Mr Wang said.

Two major projects, the Yangpu Power Plant and the Daguangba Hydroelectric Power Station, will be built in the second stage of development.

Liaoning's Jinzhou Plant Adds Final Unit

40130039b Shanghai JIEFANG RIBAO in Chinese 15 Nov 88 p 3

[Text] The Jinzhou power plant in Liaoning Province has recently put its No 6 generating unit into operation. After 8 years of construction, this power plant, a major item on the state's construction agenda, has now completed the installation of all of its six 200,000-kilowatt generator units for a total installed capacity of 1.2 million kilowatts. It is now a mainstay facility in the East China Grid and will play a large role in easing the power shortage in that region of the country.

Experts Claim Daqing Output To Remain Stable Into 1990's

40130041 Beijing ZHONGGUO XINWEN SHE in Chinese 0847 GMT 2 Dec 88

[By reporter Wei Lin: "Another Decade of Stable Production—Interview with Wang Demin, Chief Engineer of the Daqing Oil Field Administration Bureau"]

[Text] Daqing, 2 Dec (ZHONGGUO XINWEN SHE)—"It can be said with certainty that the Daqing Oil Field will maintain its stable yield for another decade between 1986 and 1995," said Wang Demin, chief engineer of the Daqing Oil Field Administration Bureau, with confidence.

Wang Demin was one of the 10 experts who made outstanding contributions and were received by the state leaders at Beidaihe last year. His mother is Swedish, and he was born and raised in China. He came to Daqing in 1960 after graduating from the Beijing Petroleum Industry Institute.

He said: "Since Daqing went into operation in 1960, China's annual output of crude oil has increased by a large margin. In 1963, crude oil production reached 4.39 million metric tons, or 67.8 percent of the country's total output. In 1985, the figure increased to 8.34 million metric tons, or 73.7 percent of China's total crude oil output; this was the year China became completely self-reliant in all oil products. In 1976, the oil field's annual output jumped above 50 million metric tons and remained steady for a whole decade. By 1985, the annual output reached 55.28 million metric tons, or 44.6 percent of China's total annual output. In 1986, Daqing began its second decade of stable yield."

"Daqing is one of the few oil fields in the world with annual output reaching or exceeding 50 million metric tons. However, compared with other large oil fields of the world, the difficulties encountered by Daqing Oil Field in oil exploitation have been unique and have been the greatest." Wang described the special characteristics of the Daqing Oil Field: shelf facies, complex geological structure, and in particular, too many thin oil layers. Reserves of thin oil layers measuring between 0.2 meter and 1 meter represent one-third of the oil field's total reserves. On the average, each well will pass through more than 100 oil layers. In other countries, reserves of oil layers less than 0.5 meter thick are not counted. In oil fields in Texas, the United States, almost all reserves are found in a single thick oil layer.

Nevertheless, the Daqing Oil Field's extraction ratio has reached as high as 2:5, which is one-third more than the norm. The Exxon Oil Company of the United States made an analysis of the Daqing Oil Field and was surprised by the high extraction ratio attained despite the complexity of Daqing's oil layers and the high viscosity of its crude. The reason is Daqing has applied the technology of injection-extraction layer-by-layer on a large scale. This technology was listed in foreign catalogs in the 1950's and 1960's, but there was hardly any application case to be found. It is unprecedented in the world for Daqing to have worked out a layer-by-layer oil exploitation system with everything provided for the operation. Following in Daqing's footsteps, some other oil fields in China have also adopted this technology. This represents a significant characteristic of oil exploitation in China with its extraordinary stratigraphic structures.

"Of course," he said, "as years go by, the difficulties in oil extraction will grow more formidable." How then can we maintain stable output? In general, on the one hand, new wells should be drilled in old production areas using new technology that can increase the extraction ratio of thin oil layers. On the other hand, efforts should be stepped up to carry out oil survey and exploitation in the surrounding oil fields and develop technologies for oil exploitation in complex oil reservoirs with low osmosis. At present, with 30 million yuan invested so far, the oil field is constructing seven experiment areas for studying basic theories, including areas to experiment with the method of shortening the distance between oil wells. It is expected that within a year, we will be able to forecast prospects for the next 40 to 50 years. At the same time, by applying the method of systems engineering as a guide, the oil field has launched trouble-shooting research activities to develop eight supplementary technologies, including the technology to survey the northern region of the Songliao Pendi for oil and gas reserves of medium and high abundance ratios and the technology to increase extractable reserves in the strata of high water content. Undoubtedly this will raise the Daqing Oil Field's technological level still further and lay the ground for continued stable yield of its crude oil.

Imported Prospecting Equipment Boosts Zhongyuan Output

40100018b Beijing XINHUA in English 0903 GMT 11 Nov 88

[Text] Zhengzhou, 11 Nov (XINHUA)—New technology and scientific developments have greatly helped China's fourth-largest oil field in its production and exploration work, according to Deputy Director of the Zhongyuan Oil Prospecting Bureau Che Zhuowu today.

Prospecting in the Zhongyuan oil field in central China's Henan Province began in 1955 but oil was not discovered until 1975 because the equipment used was not capable of the task. Now, with advanced equipment, its annual output is 51 million bbl of crude oil and 989 million cubic meters of natural gas.

To speed up oil prospecting, the oil field introduced new technology and equipment from abroad and started a campaign for further scientific and technological development in 1983. By 1986, the oil field has mastered the new technology in geological prospecting, well logging and drilling, oil and gas exploitation, and pipeline transportation.

In 1983, the oil field had proven oil deposits of only 3.6 billion bbl, but now the known reserve is up to 4.4 billion bbl.

According to the geological studies by the technicians here, the oil reserves can reach 16 billion bbl and those of natural gas, 470 billion cubic meters.

In the past, it took the oil field more than a year to complete drilling a well 3,600 meters deep, but now it only takes 4 to 5 months, since high-quality drilling mud and diamond drill bits have been introduced.

Zhongyuan To Get Big Petrochemical Complex

40100022 Beijing XINHUA in English 1202 GMT 12 Nov 88

[Text] Zhengzhou, November 12 (XINHUA)—The State Council recently approved a plan to build a 140,000-ton ethylene project in Henan Province's Puyang City inside the Zhongyuan oil field, local officials told XINHUA today.

The oil field, which covers 5,300 sq km in Henan and Shandong Provinces, is now the fifth-largest oil producer in China.

It now produces 140,000 bbl of crude oil a day. Between 1979 and 1986, it produced 189 million bbl to become the country's fifth-largest oil field, and its production of natural gas was 4.7 billion cubic meters, making it China's second-largest gas producer.

The whole project includes seven installations, including one designed with an annual hydrocarbon cracking capacity of 140,000 tons, one with an annual production capacity of 140,000 tons of polyethylene, one with an annual production capacity of 40,000 tons of polypropylene and one with an annual production capacity of 12,000 tons of butane.

The whole project, with a total investment of 1.61 billion yuan, is expected to be completed and put into operation by 1993.

When completed, the project will make full use of gas resources in the Zhongyuan oil field and help alleviate the shortage in the supply of petrochemical products in China, experts say.

They predict that the total annual income earned from the selling of petrochemical products will reach 1.03 billion yuan when the whole project is put into operation.

New Gas Field Found in Sichuan

40100021b Beijing XINHUA in English 0911 GMT 26 Nov 88

[Text] Beijing, 26 Nov (XINHUA)—A new natural gas field was found recently in the middle part of Southwest China's Sichuan Province and named the "Moxi Gasfield," according to today's ECONOMIC DAILY.

The field's reserves have been verified at 25.4 billion cubic meters, in an area of 120 square kilometers, the paper reported.

It is expected to produce 500 million cubic meters of natural gas a year.

The provincial petroleum bureau expects to have 110 wells in operation in the field by 1990.

Inner Mongolia Field Ahead of Schedule

40100021c Beijing XINHUA in English 1107 GMT 1 Dec 88

[Text] Beijing, 1 Dec (XINHUA)—An oil field in China's Inner Mongolia Autonomous Region is expected to increase its annual output to 7 million barrels (bbl) of crude oil in 1990, 2 years ahead of schedule, the ECONOMIC DAILY reported today.

The oil field consists of four oil-bearing zones in central Inner Mongolia covering an area of 61.9 square kilometers. It has a verified reserve of 558 million bbl of oil.

To achieve this goal, about 10,000 oil field workers were transferred to the field from Northeast China earlier this year.

They have sunk 235 wells with a drill footage totailing 330,000 meters, surpassing the combined number drilled in the past 7 years, the Beijing-based paper said.

In addition, oil has gushed from 233 of the 235 wells, setting a record for China's oil industry.

A 365-kilometer-long section of oil pipeline is expected to be completed by next October and construction of a refinery with an annual processing capacity of 7 million bbl of oil was begun recently, the paper said.

Exploitation at Liaohe in Full Swing

40100021d Beijing XINHUA in English 1003 GMT 1 Dec 88

[Text] Beijing, 1 Dec (XINHUA)—More than 100,000 workers and 3,000 oil rigs have been assembled in an area of 12,000 square kilometers along the Liaohe River to exploit oil reserves, the overseas edition of PEOPLE'S DAILY reported today.

Now 13 oil fields have been discovered there. China has spent billions of yuan in the opening up of these oil fields and the area has become one of the three largest oil-producing bases in China, with an annual oil output of 84 million barrels.

So far, 700 million barrels of oil and 20 billion cubic meters of natural gas have been produced.

The opening up of the oil fields has gained momentum since 1980, with an average oil output increase of 7 million barrels a year.

And more money is being spent on developing the reserves (3.4 billion yuan in 1987 and 1988) than the total amount poured into oil exploration and development by China in the 20 years previous to 1985.

First Nuclear-Powered Steam Turbine Built, Shipped to Qinshan

40100024b Beijing CEI Database in English 14 Dec 88

[Text] Shanghai (CEI)—China's first 300,000-kilowatt nuclear-powered steam turbine, manufactured by the Shanghai Steam Turbine Factory, has recently passed state approval and is being shipped to the Qinshan Nuclear Power Plant. The nuclear-powered steam turbine was entirely Chinese designed and manufactured. Nuclear experts have solved more than 40 key problems and completed more than 20 technological tests and innovations to ensure the safe running and high quality of the steam turbine.

World's Third Largest Tidal Power Station Nears Completion in Zhejiang

40130049 Beijing RENMIN RIBAO in Chinese 29 Dec 88 p 1

[Text] Zhejiang's Jiangxia reversible tidal power experimental station—the third largest facility of its kind in the world—has completed the installation of five generators with a capacity of 3,200 kilowatts. The station's total installed capacity will be 3,900 kilowatts. A major effort to develop tidal power resources would ease China's strained energy situation, and these resources have caught the interest of concerned sectors

Just how large is the real potential for tidal power development along China's extensive 18,000 kilometers of coastline? In recent years, the nation's hydropower experts have conducted surveys of the 156 bays and 33 estuaries along the coast which show that, excluding Taiwan, there are some 191 sites capable of supporting tidal power stations with a capacity of 500 kilowatts or more—a potential installed capacity of 21.58 million kilowatts.

In order to accelerate the development and use of tidal resources, the experts propose that planning, site selection, and feasibility studies be undertaken forthwith so that two or three large-scale tidal power stations can be built before the end of the century.

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